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STUDIES IN LANGUAGE AND LANGUAGE BEHAVIOR. PROGRESS REPORT NO. 3.

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THE FOUR STUDIES INCORPORATED IN THIS PROGRESS REPORT ATTEMPTED TO ANALYZE STABILIZED LANGUAGE PROCESSES AND TO EXAMINE THE COMPONENTS OF LANGUAGE PERFORMANCE, RANGING FROM SYSTEMATIC PHONETICS TO LOGICAL DISCOURSE. THE FIRST STUDY REPORTED WORK ON HUMAN AUDITORY SENSITIVITY AS A FUNCTION OF FREQUENCY AND INTENSITY. THE NEXT TWO STUDIES WERE ADDRESSED TO THE ANALYSIS OF LANGUAGE PROSODY, IN ONE CASE, NATIVE LANGUAGE, AND IN ANOTHER, PROSODY AS A SECOND LANGUAGE. THE LAST STUDY DEALT WITH A REFORMULATION OF THE AREA OF ATTITUDE CHANGE AND SELF-PERCEPTION. OTHER RESEARCH PROJECTS IN PROGRESS ARE DESCRIBED AT THE END OF THE REPORT. (GD)

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Studies in Language and Language Behavior

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GROUP A: LANGUAGE PROCESSES

Ten members of the CRLLB are currently conducting studies that analyze stabilized language processes (as distinguished from acquisition, modification, and structure of language). These studies examine the components of language performance over the entire range of "levels"--from systematic phonetics to logical discourse. Equally broad are the ranges of subjects (infant to adult, normal and impaired) and of measures (physiological and behavioral, perceptual and productive) that are employed. Four studies drawn from this ample research "space" (ample conceptually, not architecturally) are reported in the following section, and others in progress are described at the end of this report.

Strange Ross, who conducted psycho-acoustic research at the University of Copenhagen and then at Harvard University, reports the latest in a series of studies exploring human auditory sensitivity as a function of frequency and intensity, and its substrate in the mechanics of hearing. The next two studies represent a recurrent topic of Center research, the analysis of language prosody. One is addressed to the question of how we acquire the prosody of our native language, the other to how we acquire the prosody of a second language.

First, William Sheppard and Harlan Lane give a further report on their studies of that marvelous oxymoron, infant speech. Some noteworthy developmental trends in prosodic features have been uncovered, and the authors fearlessly advance physiological hypotheses to acount for them. In the finest tradition of research in this area, one of the subject infants is William Sheppard Jr., III. Breaking a different tradition, Dr. Lane proves that an administrator can still keep his hand in research.

Next, Raji Rammuny, a native of Jordan, presents extensive findings of a contrastive analysis of the prosody of English and Arabic. Although his own fluency in English belies his findings, Dr. Rammuny shows strikingly how linguistic analysis can predict interference, and how the latter can be overcome with innovations in pedagogical techniques and devices.

There are at least two good reasons to believe that Daryl Bem's self-description as a "radical behaviorist" (in the fourth article in this section) will prove self-validating. The first reason follows from his provocative reformulation of the area of attitude change. Self-perception, he argues, is a special case of interpersonal perception; we convince ourselves, just as we convince others, when the statements we make appear to be simply descriptive, rather than motivated by personal gain. Then, too, Dr. Bem's success in confirming predictions made from the position of a radical behaviorist will no doubt encourage him to explore this strategy further (as can be seen from his report of research-in-progress), and thus increase the appropriateness of his self-description.

Loudness of Pure Tones as a Function of Frequency,

Intensity, and Middle-Ear Mechanics[1]

Part III

Acoustico-Mechanical Properties of the

Middle Ear at High Stimulating Sound Intensities

Strange Ross

Center for Research on Language and Language Behavior

Abstract

Acoustic impedance at the eardrum of three Ss was determined as a function of frequency and intensity of an ipsilateral, sustained stimulating pure tone. For increasing intensity of the stimulating tone, one S showed an increasing impedance for medium to high intensities, and all three Ss showed a decreasing impedance for the highest intensities (above about 120 db SPL). It is suggested that the thresholds for these changes are reached at an equal-loudness contour, and at a contour of equal displacement amplitude of stapes, respectively, and the mechanisms for these changes are assumed to be related to the middle-ear reflex, and to a change in axis of rotation of the malleo-incudal complex, respectively. It was found that neither the 'reflex' effect nor the 'axis of rotation' effect could be duplicated on Zwislocki's middle-ear analog. However, by extending this analog so as to incorporate a circuit representing the effect of a changing axis of rotation of the malleo-incudal complex, it was possible to duplicate closely the observed decrease in acoustic impedance with increasing intensity. The middle-ear transmission for this extended analog was computed, and its effect on the form of matching functions and equal-loudness contours is discussed.

Introduction

As described in detail in Part II of the present report, acoustic impedance at the right eardrum of three Ss was measured as a function of frequency and intensity of a stimulating tone emitted by an acoustic bridge to the ear under test. Measures were collected in series, separated by rest periods. During each series of determinations the acoustic bridge was left in place on the ear, and for a given frequency the intensity of the tone emitted by the bridge was raised in steps of 5 or 10 db from the lowest level that still permitted a null to be detected, to the maximum level which the S could tolerate. For each of 10 frequencies, Ss JR and FP completed four series, and S LL two series of impedance determinations. During each series of measurements, the stimulating tone was left on continually, and the measurements were performed as rapidly as possible, that is, at the rate of approximately one per minute. Thus, the results to be reported here concern the acoustic impedance at the eardrum under sustained stimulation by a pure tone.

Results

The measures of acoustic resistance and reactance obtained from each S are displayed in the complex impedance plane in Figs. 1 - 3 with frequency as the parameter. Each point is the average of repeated determinations at

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Insert Figs. 1 - 3 about here

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a particular intensity of the stimulating tone. (For graphical clarity the data for 80 cps have been omitted for S JR, and the resistances for 320 cps and 800 cps for S FP have been multiplied by factors of 2 and 2.5, respectively.) Figs. 4 - 9 (replicating Figs. 7 - 9 of Part II of this report) present the same data as a function of the intensity of the stimulating tone, with frequency as parameter.

Insert Figs. 4 - 9 about here

Examination of Figs. 1 - 9 reveals a number of more or less clear-cut stages in the change in impedance with increasing intensity of the stimulating tone. Some of these stages are more apparent for some Ss than for others, and some stages are non-existent for some Ss. For increasing intensity of the stimulating tone, the stages are as follows. 1) Up to a certain level of the intensity of the stimulating tone, the acoustic impedance at the eardrum appears to be constant. 2) When the intensity is increased beyond this level, the negative reactance increases. This increase may be accompanied by an increase or a decrease of the resistance, or the resistance may remain constant. 3) At a somewhat higher level, the negative reactance begins to decrease. 4) At a still higher level, the resistance begins to decrease, sometimes after a preceding increase. The decrease in negative reactance initiated in the preceding stage continues. 5) For the very highest intensities of the stimulating tone, both resistance and negative reactance reach a final stable level.

Of these five stages, stage 1 is found for all three Ss. Stage 2 is apparent in the data of S JR for frequencies including and above 125 cps, and for S FP in the data for frequencies including and above 320 cps. For S LL, this stage is vaguely evidenced in the data for 320 cps and 800 cps. Stage 3 and stage 4 are clearly exhibited by all Ss, for all frequencies tested. Finally, stage 5 is clearly in evidence only for S FP, for frequencies from 20 cps to 200 cps; S LL possibly exhibits this same stage from 20 cps to 320 cps.

It should be noted from Figs. 1 - 3 that the impedance changes occurring during stage 4 are such as to follow the impedance pattern of stage 1; that is, impedance changes during stage 4 are approximately equivalent to impedance changes produced by increasing the frequency of the stimulating tone at intensity levels below the onset of impedance changes.

Discussion

Thresholds for various stages of impedance change

In this and in the following sections, two kinds of analyses of the data presented in Figs. 1 - 9 will be attempted. First, the 'thresholds' for the various stages of impedance change will be related to other relevant information. Second, an attempt will be made to account for these stages by means of the middle-ear model described in Part II of this report.

As will be evident from Figs. 4 - 9, the 'thresholds' of the five stages of impedance change enumerated above are not very clearly defined. Therefore, rather than attempting to extract these thresholds from the data, a hypothesis concerning the threshold of each stage will be advanced, and the corresponding predictions will be compared with each set of actual data. This procedure in no way constitutes a proof of the hypotheses advanced; however, the data do not seem to warrant any more refined treatment.

It is proposed that the threshold for the onset of the initial change in impedance coincides with an equal-loudness contour for the stimulating tone. (Due to the lack of definition of this threshold, the proposal just mentioned is practically indistinguishable from the assertion that the threshold coincides with a given sensation level of the stimulating tone. For theoretical reasons, however, the former formulation is preferred.) For each _S_, the values of the best-fitting equal-loudness contour (from Tables 2 - 4 in Part I of this report; see also Table 1) have been plotted in Figs. 4 - 9. The correspondence between

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Insert Table 1 about here

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the onset of change of reactance and these plotted values is satisfactory for _Ss_ JR and FP. In the case of _S_ LL, the transition from stage 1 to stage 2 is so poorly defined as not to permit an evaluation of the hypothesis advanced. Further, in the case of _S_ JR, there is a reasonably good correspondence between the predicted values and the onset of change in resistance.

It is further proposed that each of the transitions between stages 2, 3, 4, and 5 occur, for a given _S_, at given displacement amplitudes of stapes.

Even though information concerning the relation between stimulating sound intensity and resulting stapes displacement amplitude is available from the middle-ear models for each S discussed in Part II of this report, this information is not directly applicable to the present data. The reason for this is that the models of Part II are based on the initial levels of impedance (that is, those belonging to stage 1), and not upon the levels of impedance and their associated acoustico-mechanical conditions at the subsequent stages of impedance change. However, in the absence of more pertinent information, we shall assume that the displacement amplitudes of stapes as calculated from the above-mentioned models are still applicable in an approximate sense to the data at hand.

In Figs. 4 - 9 the best-fitting sets of stimulating sound intensities corresponding to (approximately) equal stapes displacement amplitudes have been plotted for the following transitions: stage 2 - stage 3 (reactance); stage 3 - stage 4 (resistance); and stage 4 - stage 5 (resistance and reactance). The numerical values of these equal-displacement contours are listed in Table 1. The correspondence between the plotted values and the points of transition must be regarded as quite satisfactory.

It will be noticed from Figs. 5, 7, and 9 that stage 2 (that is, an increase in negative reactance) is never evidenced when the predicted threshold of this stage exceeds the predicted threshold of stage 3 (that is, a decrease in negative reactance). It is tempting to conclude that the mechanism associated with stage 3 is 'stronger' than that associated with stage 2, and thus 'blocks' the effect of this latter stage.

The fact that the thresholds of the various stages seem to be associated with two different variables, i. e., loudness and amplitude of stapes displacement suggests that two different mechanisms are involved in the observed impedance changes. The mechanism responsible for the changes belonging to stage 2 undoubtedly is the contraction of the middle-ear muscles, while the mechanism responsible for the succeeding stages presumably is related to changes in the axis of rotation of the ossicles, as described by Bekesy (1960).

Analog approximations of 'reflex' effect

Part II of the present report included a description of how the parameter values of the middle-ear analog developed by Zwislocki (1962) were adjusted for each S so as to make the input impedance of the analog conform as closely as possible to the observed initial stable levels of the acoustic impedance at the eardrum. A diagram of this analog network is given in Fig. 10 (replicated from Part II of this report). We shall now investigate whether the

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Insert Fig. 10 about here

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observed changes in acoustic impedance with increasing intensity of the stimulating tone can be replicated on the analog networks by appropriate adjustments of a single parameter, or of a simple combination of parameters.

Since the impedance changes presumably associated with the activation of the middle-ear muscles are exhibited clearly only by S JR, this kind of impedance change will be explored relative to the analog developed for this S. In looking for possible candidates among the parameters which might be able to produce the observed changes, all the inductances may at once be dismissed on the grounds that their effect is either limited to the highest frequencies tested, or is negligible. Likewise, all resistances - in isolation, at least - may be dismissed on the grounds that their effect is mainly one of changing the resistive component of the input impedance.

Among the capacitances of the analog network we may dismiss those that correspond to more or less fixed properties of the middle ear. This eliminates C_t and C_p, both of which represent certain volumes of air, the size of which presumably is independent of any action of the middle-ear muscles. Further, C_{d2}, that is, the compliance of the part of the eardrum not directly coupled to the malleus, may be dismissed due to its negligible effect on the input impedance.

This process of elimination leaves us with four possible candidates to account for the observed impedance changes: C_{d1}, C_o, C_s, and C_c, representing the compliances of the part of the eardrum directly coupled to the malleus, of the suspension of the malleo-incudal complex, of the incudo-stapedial joints, and of the stapedius muscle and the oval and the round windows, respectively. The computed effects of each of these four parameters in isolation on the input impedance of the analog network are shown in Fig. 11. Dots within a circle

Insert Fig. 11 about here

represent the 'normal' values of the input impedance. The value of each parameter is varied over a range from 2 times its normal value to at least 1/2 times this value. Arrows on the lines connecting corresponding points indicate direction of impedance change for increasing parameter value, that is, for increasing compliance.

Comparison of Figs. 1 and 11 shows that variation of C_o produces the desired change of input impedance for 500 cps, but not for any other frequency. Further, it will be seen that variation of C_c results in impedance changes in approximately the correct directions for all frequencies, but of a quite insufficient range. Covariation of C_o and C_c does not remedy this situation, neither when these parameters are varied in direct proportion, nor when they are varied according to ($\sqrt{k}\ C_o$, $k\ C_c$). Various other attempts at producing the desired changes in input impedance also failed.

The conclusion to be derived from these negative results seems to be that the analog network (for this S, at least) does not represent a sufficiently accurate model of the middle-ear mechanics to be able to account for the changes in acoustic impedance at the eardrum brought about by activation of the middle-ear muscle reflex.

Among other things, this failure to account for the initial stages of impedance change for S JR leaves open the question of whether the apparent re-tracing of the acoustic impedance after the negative reactance has reached its maximum value is due to adaptation, or to the effect of a subsequent and different mechanism.

Analog approximations of 'axis of rotation' effect

That kind of impedance change which is characterized by being approximately equivalent to the effect of an increase in frequency (stage 4), is clearly exhibited by all three Ss (Figs. 1 - 3). Since the analog parameter values derived for S LL (presented in Part II of this report) are comparable to those for S FP, and to the average values contained in Zwislocki's analog network, the data of S LL will be selected here for an analysis of this effect.

As was the case for the analog network for S JR described in the previous section, all parameters except C_{d1}, C_o, C_s, and C_c may be dismissed from the analysis on the grounds either that they represent supposedly fixed properties of the middle ear, or that their effect on the input impedance of the network is negligible. Figure 12 presents the 'normal' impedance values for the analog

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Insert Fig. 12 about here

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network adjusted for S LL, together with the impedance changes due to isolated variation of the above four parameters. Comparison with Fig. 2 reveals that an increase of the value of C_{d1} generates the desired kind of impedance change for the lower frequencies, but that the direction of this change deviates more and more from the desired direction, the higher the frequency. No other parameter, when varied in isolation, produces impedance changes approaching those observed at the eardrum.

The possibility exists that the variation of a combination of parameters would yield the desired kind of impedance change. The most likely combination is that of C_{d1} and C_o, whose combined effect is plotted on Fig. 12. It will be seen that this combination produces directions of impedance change which, as a whole, may be regarded as slightly more satisfactory than those produced by variation of C_{d1} alone, but which still depart significantly from the observed directions of impedance change.

Also in this case, then, the conclusion seems to be that the analog network proposed by Zwislocki is not a sufficiently accurate representation of the middle-ear mechanics to allow a simulation of the second major kind of impedance change observed at the eardrum.

If the kind of impedance change under consideration is regarded as due to a shift in the axis of rotation of the ossicles, as suggested earlier, this negative result is not very surprising, since the analog network developed by Zwislocki was not intended to account for this kind of mechanism. It has been attempted, therefore, to modify Zwislocki's model in such a way as to fulfill this added function. This extended model, the derivation of which is described in detail in an appendix to this report, is based on the following considerations. The goal was to design a model of the middle-ear mechanics that would allow a shift of the axis of rotation of the malleo-incudal complex to result in a reduction of the impedance at the eardrum. This goal was attained by utilizing Bekesy's observation that at high sound intensities the axis of rotation of the stapes shifts from one perpendicular to the long axis of the footplate, to one parallel to this axis. Since the suspension of the footplate apparently is symmetrical with respect to its long axis, a rotation around this axis results in only local displacements of the fluid behind the footplate. This, again, means that in this mode of vibration the loading of the footplate normally exerted by the cochlear complex is removed, with a consequent increase of the mobility, or decrease of the impedance, of the entire middle-ear system. This shift in the axis of rotation of the stapes footplate is assumed to be brought about by a shift in the axis of rotation of the malleo-incudal complex. The exact mechanism of this latter shift has not been accounted for in the extended model, but it is assumed to be due to different non-linear characteristics of the ligaments supporting the malleo-incudal complex. Thus, this mechanism is conceived of as operating 'passively,' that is, without the intervention of any neuro-muscular events, being dependent only upon the displacement amplitude of the transmitted vibrations.

It should be pointed out that the above-mentioned extended model of the middle-ear mechanics is offered more as an academic exercise than as a realistic model. In addition to the uncertainty as to the basic mechanism just described, this attitude is dictated by the fact that a large number of quite arbitrary assumptions concerning the geometry and the mechanical properties of the systems involved had to be made. In spite of these limitations, it is hoped that this extended model may serve a useful, although limited, purpose.

The extended analog network is derived by substituting the last two branches of Zwislocki's network (Fig. 10) by the network of Fig. 13. Indices

Insert Fig. 13 about here

for the impedances of this network have the following meaning: st - stapedius muscle; ℓ - ligaments of stapes footplate at anterior end of long axis; sh - ligaments of footplate at ends of short axis; c - cochlear complex; sj - incudo-stapedial joint. The quantity k is a measure of the displacement of the axis of rotation of the malleo-incudal complex; k = 1 signifies no displacement, and k = 0 signifies maximal displacement.

Setting, $Z_x = Z_{st} + 2Z_\ell + \frac{1}{2}Z_c$, and expanding each impedance into components, the electrical equivalent of Fig. 14 is obtained. (The only mass component of

Insert Fig. 14 about here

the system is the one associated with the cochlear complex.) This network, in conjunction with the remaining part of Zwislocki's network, was used for programing a computer (Digital PDP-4) to calculate the resistive and the reactive component of the input impedance, and the transmission of the network (see Appendix).

Through a process of trial and error, a new set of parameter values for the initial impedance levels was arrived at. These values are given in Table 2, together with the parameter values for Zwislocki's analog for this

Insert Table 2 about here

S (LL) as arrived at in Part II of this report. As will be noticed, only minor changes in the values of parameters occurring in both models have been made, with the exception of the values of C_o and R_o which have been multiplied and divided by a factor of 4, respectively. Many of the minor changes may not have been absolutely necessary, or similar changes might have been made in

Zwislocki's model without any significant deterioration of the desired input impedances. (Comparison with the permissible ranges of the parameter values for Zwislocki's model, given in Table 2, Part II, shows that only the new values of C_p and C_o exceed this range.)

The effect of varying individual parameters of the extended analog was very similar to that found for Zwislocki's analog. Again, the relevant parameters are the capacitances (compliances) representing non-fixed properties of the middle ear, that is, C_{d1}, C_{d2}, C_o, C_x, C_{sh}, and C_{sj}. Of these, C_{d2}, C_x, and C_{sj} were found to have practically no effect on the input impedance, (although C_x was found to affect the transmission appreciably). For the remaining three parameters, the effects of C_{d1} and C_o were found to be almost identical to the effect of these parameters in Zwislocki's model as shown in Fig. 12, and the effect of C_{sh} was found to practically duplicate the effect of C_o.

Due to these close similarities in the effects of the relevant parameters in the two models, we may again conclude that among these parameters, C_{d1} is the only candidate for approximating the desired impedance changes. Figure 15 shows the effect on the input impedance of the extended analog network of

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Insert Fig. 15 about here

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changing the value of C_{d1} from .28μf to .45μf. For comparison, this figure also replicates the changing acoustic impedances as observed for S LL, previously given in Fig. 2.

Figure 15 further shows the effect of subsequently changing the value of k from 1.0 to .50 and to .10, that is, the effect of dislocating the axis of rotation of the malleo-incudal complex. Values of k below .10 yield only minor further changes in the input impedance, (although the transmission continues to be affected). This combination of parameter changes was found to provide the closest approximation to the observed changes in acoustic impedance. Isolated variation of k, as well as of C_{d1}, did not produce comparable results. The correspondence between observed and calculated values as displayed in Fig. 15 must be regarded as very satisfactory, although reservations may be held as to the soundness of the model involved.

In case C_{d1} is regarded as a relevant parameter for the observed reduction in acoustic impedance at the eardrum with increasing intensity of the stimulating tone, the question arises - irrespective of whether Zwislocki's model or the extended model is assumed - as to how this change in the compliance of part of the eardrum is brought about. One possibility seems to be to assume that the handle of malleus is displaced in the direction toward the eardrum at these higher intensities, thereby creating a slack 'fold' between these two elements. This displacement conceivably may be brought about either through a contraction of the stapedius, sufficient to more than counteract the effect of a contraction of the tensor tympani, or through the displacement of the axis of rotation of the malleo-incudal complex. It would seem possible to subject this contention to a direct test by microscopically observing the eardrum when stimulated by high sound intensities.

In teleological terms, the extended model provides the following conception. As the stimulating sound intensity reaches a certain level, the stapedius begins to contract. Although this contraction (according to the extended model) has practically no effect on the input impedance, it serves two different purposes. As suggested by Bekesy, it increases (possibly in conjunction with an activation of the tensor tympani) the forces acting on either side of the ossicular joints, thereby preventing "clatter" at high accelerations (as encountered at high intensities and high frequencies). Also, it significantly reduces the transmission from eardrum to cochlear fluid, thereby affording a protection of the inner ear.

This reduction in transmission was found to be practically independent of frequency. When the parameter C_x, which contains the compliance of the stapedius as a component, takes on the values of .40, .20, .10, .05, .01, and .001 μF, the corresponding transmissions (expressed as 20 times the logarithm of the ratio of the resulting volume velocity of the cochlear fluid to the stimulating sound pressure at the eardrum) were found to equal -90.0, -92.3, -95.7, -100.2, -112.8, and -132.5 db at 200 cps.

At still higher intensities of the stimulating sound, the handle of the malleus moves closer to the eardrum. As a result, the compliance of the area of the eardrum closest to the malleus is increased, and the acoustic impedance at the eardrum is decreased. This change in compliance has only a very small effect on the transmission from eardrum to cochlear fluid, and may actually result in a better transfer of acoustic energy from a free-field sound wave to the middle ear, due to the closer matching of impedances of air and eardrum. If this change in compliance has any teleological function at all, it may consist in a protection of the eardrum itself.

Finally, a change in the axis of rotation of the malleo-incudal complex takes place, due, presumably, to non-linearities in the supporting ligaments. The resulting change in the mode of vibration of stapes results in a reduced transmission to the cochlear fluid, thus constituting an additional protective mechanism. This decrease in transmission was found to be practically independent of frequency (as was the case for the reduction in transmission caused by the stapedius). For the four combinations of parameter values listed in Fig. 15, the corresponding transmissions at 200 cps were found to equal -90.0, -90.4, -95.0, and -108.6 db; (a change of axis of rotation is associated with the latter two values).

On the basis of this conception, it is possible to assess the effect of changes in the transmission of the middle-ear on the matching functions (and, thus, on the equal-loudness contours). According to the extended middle-ear model, contraction of the stapedius significantly reduces the middle-ear transmission. For a given degree of contraction, this reduction is assumed to be independent of frequency. Assuming that the threshold for activation of the stapedius coincides with an equal-loudness contour, and, further, that the function relating loudness and resulting degree of contraction also is independent of frequency, then all loudnesses of a given level, associated with different frequencies, will be reduced by the same amount. Since the matching functions in the intensity range under consideration closely approach straight lines with a slope of 1.0, such a constant reduction of loudness values will have no effect on the matching functions. Consequently, the equal-loudness contours in this intensity region will also remain unaffected by a contraction of the stapedius.

While changes in the compliance of the eardrum have no effect on the middle-ear transmission, a change of the axis of rotation of the malleo-incudal complex - according to the extended model - affects transmission, again independently of frequency. Since this latter effect sets in at sound pressure levels corresponding to equal displacement amplitudes of stapes (that is, at levels departing from an equal-loudness contour), we should expect a break to occur in each (or some) matching function at a point corresponding to one of the component tones reaching this critical level. Inspection of the matching functions of Figs. 23 - 25 of Part II, in conjunction with the levels for the onset of the 'axis of rotation' effect indicated in Figs. 4 - 9, however, does not seem to substantiate this prediction.

Appendix

Derivation of Extended Analog Network for the Stapedio-Cochlear Complex

Spatial specifications for incudo-stapedial complex

The following specifications of the relative positions of the oval window, stapes, incus, and the normal axis of rotation of malleus-incus have been arrived at under consideration of two points: 1) these specifications should be reasonably close to the available anatomical information; 2) the resulting geometry should be as simple as possible. The anatomical information was gathered from standard textbook illustrations (e.g., Bekesy, 1960; Wever & Lawrence, 1954), and especially from the semi-solid representations in Pernkopf's Atlas (1963).

Imagine a three-dimensional coordinate system with its origin located at the center of the oval window, with its x-axis along the long axis of the oval window, and its y-axis along the short axis of this window. The z-axis of this coordinate system then passes through the axis of symmetry of stapes. Let us assume, for the sake of simplicity, that the height of stapes equals the length ℓ of the long axis of its base, and that the short axis of its base equals one half of the long axis. The top of stapes, T, thus receives the coordinates (o, o, ℓ).

The following more or less arbitrary assumptions are made concerning the location of incus and the normal axis of rotation of malleus-incus: 1) the tip of the short process of incus is attached by short ligaments to the bony wall of the middle ear at point C with coordinates $(-\ell, 2\ell, 2\ell)$ (see Fig. 16);

Insert Fig. 16 about here

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2) the normal axis of rotation of malleus-incus falls in a plane parallel to the xz-plane; 3) the line CT is perpendicular to the normal axis of rotation of malleus-incus, that is, CT coincides with the arm of force attacking the top of stapes through the incudo-stapedial joint.

From these assumptions, the angle formed by the normal axis of rotation with the xy-plane is determined in the following way. The line CT is rotated around the sought-for axis until it lies in a plane parallel to the xz-plane (through C). This new position of CT is identical to the projection of the original line CT on the plane mentioned, since it is assumed that CT is perpendicular to the axis of rotation, and since the projection of a right angle on a plane containing one leg of this angle is always a right angle. Therefore, from an xz-projection of CT, the angle formed by the axis of rotation can be determined to 45° (see Fig. 16).

Assuming further that the normal axis of rotation of malleus-incus passes through the center of gravity of this complex, the approximate location of this center would be at point G with coordinates $(o, 2\ell, 3\ell)$.

Decomposition of normal force on three principal axes

For a given force f acting on the top of stapes, the component forces f_x, f_y, and f_z in each of the three principal directions are derived from the geometry of the system in the following way.

The force f, which is contained in the vibratory plane perpendicular to the axis of rotation through C, projects onto the same line in the xz-plane as that into which the vibratory plane itself projects. We already know from the xz-projection of Fig. 16 that this line forms 45° with the axes. It thus follows that

(1) $f_x = f_z$.

Figure 17 shows the geometry of the vibratory plane. The plane is deter-

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Insert Fig. 17 about here

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mined by three points: C, T, and F. Points C and T are already known. Point F is indicated on Fig. 16, and is the projection of C on the xz-plane. Since the axis of rotation is parallel to the xz-plane, FC must be perpendicular to this axis, and thus must be contained in the vibratory plane, that is, F is a point in the vibratory plane.

Since F is the projection of C on the xz-plane, and since FT is contained in the xz-plane, it follows that $\angle$ TFC = 90°. From Fig. 16 it is easily seen that FC = 2ℓ, and that FT = $\sqrt{2}\ell$; it follows that TC = $\sqrt{6}\ell$.

The line FC is parallel to the y-axis. Therefore, the projection of the force f (acting perpendicular to the arm of force TC) on a line through T and parallel with FC is the y-component of f. From similar triangles we obtain:

$$(2) \quad \frac{f_y}{f} = \frac{\sqrt{2}\ell}{\sqrt{6}\ell}; \qquad f_y = \sqrt{\frac{1}{3}}\, f.$$

Since FT is contained in the xz-plane, the projection of f on this line yields the xz-component of f. Similar triangles give:

$$(3) \quad \frac{f_{xz}}{f} = \frac{2\ell}{\sqrt{6}\ell}; \qquad f_{xz} = \sqrt{\frac{2}{3}}\, f.$$

From (1) we already know that the components of f along x- and z-axes are identical; it follows that

$$(4) \quad f_x = f_z = f_{xz} \cos 45° = \frac{\sqrt{2}}{2} f_{xz};$$

that is,

$$(5) \quad f_x = f_z = \frac{\sqrt{2}}{2}\sqrt{\frac{2}{3}}\,f = \sqrt{\frac{1}{3}}\,f.$$

We thus see that the component forces along all three principal axes equal $\sqrt{\frac{1}{3}}\,f$. This, incidentally, means that the force f forms the same angle with all three principal axes and, therefore, with all three principal planes.

Discussion of various ways in which axis of rotation of malleus-incus may change

The purpose of the following considerations is to explain the empirical finding that the mobility at the eardrum, after a minor decrease, shows a pronounced increase with increasing sound intensity. (In the present context, 'mobility' is a more convenient concept than impedance. 'Mobility' is the inverse of 'impedance.') The initial decrease of mobility will be explained by the action of the middle-ear muscles. In explaining the subsequent increase, the basic notion is that the mobility of the stapes is much greater around the long axis of the footplate than around the short axis. The reason for the high mobility in the one case is that the stapes is symmetrically suspended with respect to the long axis of the footplate. This means that, as the stapes is rotated around this axis, the fluid of the inner ear immediately behind the footplate is moved back and forth between the two long rims of the footplate, without transmitting any volume displacement to the remainder of the fluid. In this way the low mobility of the remainder of the fluid is effectively by-passed, resulting in a high mobility of the stapes. However, the stapes is not symmetrically suspended with respect to the short axis of the footplate. The ligaments at one end of the long axis are assumed to be quite short, while those at the other end are assumed to be so long as to actually be slack whenever the stapedius muscle is not contracted.

Even when the stapedius _is_ contracted, the greater length of these ligaments is assumed to render these considerably more compliant than the short ligaments at the other end of the footplate. The result is that for forces parallel to the long axis (and for forces perpendicular to the footplate), the stapes effectively rotates about one end of the long axis, thus causing displacements of the entire volume of fluid in the inner ear. The mobility for forces in these directions thus is considerably lower than for forces parallel to the short axis.

Bekesy (1960) observed how the mode of vibration of the ossicles changed as a function of intensity so as to shift from a direction of vibration parallel to the long axis of the footplate to one parallel to the short axis. Bekesy stresses the reduction of sound transmission to the inner ear thus obtained, and describes this reduction as a protective device. This mechanism, which essentially consists of a change in the axis of rotation of malleus-incus, seems able to explain the observed changes in mobility at the eardrum by assuming that the incus is loaded with a mobility that varies as a function of the axis of rotation, which again is assumed to vary as a function of vibration amplitude and, thus, sound intensity.

Unfortunately, however, sufficient anatomical data are not available to permit any greater degree of deductive reasoning with respect to the nature of the mechanics responsible for this change of axis of rotation. Therefore, the following discussion of some possible mechanisms is based mainly on purely heuristic criteria, i.e., these mechanisms shall be able to account for the observed changes in mobility, and at the same time these mechanisms shall be as simple as possible. It is assumed, though, that these mechanisms are effected without the help of any muscle contractions, and only through non-linearities of the ossicular suspensions. (Strictly, therefore, we should talk about changes in 'effective axis of rotation.') Spelled out in terms of the component forces attacking the top of the stapes, this means that we are looking for a reasonably simple kind of change in the axis of rotation which will cause an increase of f_y (working into a high mobility) and a decrease of f_x and f_z (working into low mobilities). Furthermore, since the observed changes in mobility at higher sound intensities are quite drastic (up to a three-fold increase), and since a change in mobility as seen from incus most likely is not reflected intact on the mobility at the eardrum, the sought-for change in axis of rotation should be able to effect a considerable increase of the y-component relative to the total force attacking the top of stapes.

As mentioned before, the short process of incus is attached to the bony wall of the middle ear by short ligaments (at point C, Figs. 16 and 17). This anatomical datum would make it reasonable to assume that C is a fixed point of rotation, that is, that changes in axis of rotation of malleus-incus are effected through a rotation of some kind of this axis around point C. It can be shown, however, that the normal axis of rotation produces the maximum value of f_y/f obtainable for any axis of rotation passing through C. In order to demonstrate this, we will account for the changes in f_y/f produced by rotating the axis of rotation in each of two planes perpendicular to each other through the normal axis. Combinations of these two kinds of rotation will produce all possible axes of rotation through C.

The first plane to be considered is the plane determined by the normal axis of rotation and the line CT. For any axis of rotation contained in this plane, and passing through C, the direction of the resulting force at T will remain the same, although the magnitude of this force will vary. Consequently, the ratios f_x/f, f_y/f, and f_z/f will remain invariant to this kind of change of axis of rotation.

The plane through the normal axis of rotation perpendicular to the plane just considered is the plane perpendicular to CT through C. When the axis of rotation is rotated around C in this plane, the vibratory plane changes its orientation. As a consequence of the particular geometry of the system it so happens that the normal plane of vibration contains a line through T parallel to the y-axis. This, in turn, means that the normal y-component of the force is contained in the vibratory plane. For any other orientation of the vibratory plane (no longer containing a line through T parallel to the y-axis), the y-component of f will appear as the projection on the y-axis of the normal y-component. Since a projection is never greater than the magnitude projected, it follows that f_y/f attains its maximum value for the normal axis of rotation.

It thus appears that we cannot maintain the assumption that point C always falls on the axis of rotation of malleus-incus. In order to increase the ratio f_y/f, the axis of rotation must move closer to the xz-plane, that is, the plane through the long axis of the footplate and the top of stapes. Among the many possibilities for such a movement, we choose the simplest one: we assume that the axis of rotation from its normal position performs a simple translation in the direction of the y-axis toward the xz-plane. As the limiting case, the axis of rotation reaches (and is contained in) the xz-plane. This particular assumption implies that while the arm of the force and the direction of the force change with changing axes of rotation, the plane formed by the arm and the force (i.e., the vibratory plane) remains fixed. For the purpose of further simplification let us assume that the lever ratio of the malleus-incus lever remains constant for varying axes of rotation (due to a shortening of both arms of this lever); this means that the magnitude of the resulting force is independent of the position of the axis of rotation. In addition, we will assume (for the time being, at least) that the increase in rotational inertia of malleus-incus owing to the movement of the axis of rotation away from the center of gravity of this complex can be disregarded. (It is realized that this assumption [as well as the preceding one] violates the conclusion reached by Zwislocki (1962) from an analysis of Møller's (1961) work, according to which the axis of rotation of malleus-incus must always pass through, or at least near, the center of gravity of this complex. We see no other way, however, of attaining the desired mechanism.)

Figure 18 illustrates how the component forces change as a function of the position of the axis of rotation. The plane represented is the vibratory

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Insert Fig. 18 about here

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plane, and since this coincides with the normal vibratory plane for all axes of rotation, the plane of Fig. 18 is identical to that of Fig. 17. Point R is the intercept of the instantaneous axis of rotation and FC, and, since the axis of rotation is perpendicular to FC, R is also the projection of this axis. The distance FR is denoted by $2k\ell$, $o \le k \le 1$.

From Fig. 18 we obtain the following relations:

(6) $$TR = \sqrt{2\ell^2 + 4k^2\ell^2} = \sqrt{2}\sqrt{1 + 2k^2}\ \ell$$

(7) $$f_y/f = TF/TR = \sqrt{2}\ell/\sqrt{2}\sqrt{1 + 2k^2}\ \ell = 1/\sqrt{1 + 2k^2}$$

(8) $$f_{xz}/f = FR/TR = 2k\ell/\sqrt{2}\sqrt{1 + 2k^2}\ \ell = \sqrt{2}\ k/\sqrt{1 + 2k^2}.$$

Since the vibratory plane intersects the xz-plane under 45° with the x- and z-axes, it follows that

(9) $$f_x = f_z = \frac{\sqrt{2}}{2} f_{xz},$$

that is,

(10) $f_x/f = f_z/f = \frac{\sqrt{2}}{2} f_{xz}/f = \frac{\sqrt{2}}{2} \sqrt{2}\, k/\sqrt{1 + 2k^2} = k/\sqrt{1 + 2k^2}$,

or,

(11) $f_x = f_z = kf_y = \dfrac{k}{\sqrt{1 + 2k^2}} f.$

Mechanical properties of incudo-stapedial complex

The incudo-stapedial complex consists of the following components: 1) incus, with its attachments to malleus and to the bony wall of the middle ear; 2) stapes, with its ligaments connecting the footplate with the oval window; 3) the incudo-stapedial joint, connecting the tip of the long process of incus with the top of stapes; and 4) the stapedius muscle, attached to the top of stapes.

The following mobilities are involved in this system: a) the mobility of the top of a stapes disconnected from stapedius and incus; b) the mobility of stapedius; c) the mobility of the incudo-stapedial joint; and d) the mobility of the tip of the long process of incus, i.e., the mobility of incus as seen from the incudo-stapedial joint. The mobility of stapes is a complex function of the mobilities of the ligaments supporting the footplate in the oval window, of the fluid of the cochlea, and of the round window. The mobility of incus can be divided into three parts: d1) A mobility around the axis of rotation of malleus-incus; this component is contained in the preceding stages of the model and need not be considered here. d2) A mobility around an axis perpendicular to the axis of rotation and perpendicular to the arm of the force. d3) A translational mobility in the direction of the arm of the force.

A number of assumptions will be made concerning the nature of these mobilities and their contribution to the total mobility of the system:

I. As mentioned before, it is assumed that the footplate is suspended symmetrically in the oval window along its long axis.

II. It is assumed that, due to the small angular amplitudes, the short ligaments suspending the posterior end of the footplate effectively act as a frictionless hinge.

III. According to Bekesy (1949), the mobility of the incudo-stapedial joint is considerably higher in the direction of the long axis of the footplate than in the direction of the short axis. Since the angular amplitudes encountered between the arm of force and the joint will always be small, the rotational mobility of the incudo-stapedial joint may be assumed infinite. Consequently, the incudo-stapedial joint will be conceived of as a frictionless hinge with its axis parallel to the long axis of the footplate (i.e., the x-axis), and permitted to slide back and forth in the direction of its axis under the control of a mobility consisting of a compliance and a resistance.

IV. Due to the small angular amplitudes between stapes and the arm of force, the mobility mentioned under d2 above will be assumed effectively infinite.

V. Assuming that the postulated high mobility in the x-direction of the incudo-stapedial joint is much greater than the translational mobility of malleus-incus mentioned under d3 above, we may regard this translational mobility as effectively being zero.

VI. The stapedius muscle will be assumed to act on the top of stapes in the anterior direction of the x-axis.

Mobility of stapedial complex

The total mobility of the stapedial complex as seen from the tip of incus is determined by computing the partial mobilities of this system for each of the three principal directions. From these partial mobilities the total velocity u resulting from application of force f can be computed. The total mobility, then, is determined as the projection of this velocity on the direction of the force, divided by the force.

The partial mobility z_x in the x-direction appears as the sum of the mobility of the incudo-stapedial joint, z_{sj}, and the mobility in the x-direction of the top of stapes. This latter mobility, z'_x, may be determined under reference to Fig. 19, showing the arrangement of the component mobilities in

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Insert Fig. 19 about here

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the xz-plane. In this figure, z_ℓ denotes the mobility of the long ligaments attached to the anterior end of the footplate; z_k denotes the mobility of the midpoint of the footplate, and equals the parallel combination of the mobility z_{sh} of the short ligaments attached to the upper and the lower side of the footplate, and the mobility z_c of the fluid of the inner ear; and z_{st} denotes the mobility of the stapedius muscle.

The mobility z'_x is easily determined to:

$$(12) \quad z'_x = z_{st} \,||\, \frac{1}{2} z_\ell \,||\, 2 z_k.$$

Adding to this expression the mobility of the incudo-stapedial joint, and substituting the component mobilities of z_k, we get:

$$(13) \quad z_x = z_{sj} + \{z_{st} \,||\, \frac{1}{2} z_\ell \,||\, z_{sh} \,||\, 2 z_c\}$$

While in the x-direction the attacking force acted <u>through</u> the mobility z_{sj}, in the z-direction it acts <u>on</u> this mobility, in parallel with the z-mobility of the top of stapes. Figure 20 gives the arrangement of the component mobilities, again in the xz-plane. Simple computations give:

(14) $z_z = \frac{1}{2} z_{sj} \,||\, \frac{1}{2} z_{st} \,||\, \frac{1}{4} z_{\ell} \,||\, \frac{1}{2} z_{sh} \,||\, z_c.$

Insert Fig. 20 about here

Finally, the y-mobility of the stapedial complex is determined only by the dimensions of the system, and by the mobility z_{sh} of the short ligaments (see Fig. 21). We find:

(15) $z_y = 8\, z_{sh}.$

Insert Fig. 21 about here

We can now proceed to calculate the total mobility $z = u_f/f$. Since $z_x = u_x/f_x$, $z_y = u_y/f_y$, and $z_z = u_z/f_z$, and since f_x, f_y, and f_z are known, u_x, u_y, and u_z are also known. In order to compute u_f/f, we have to project the vector U (u_x, u_y, u_z) on the vector F (f_x, f_y, f_z). The angle ϕ between these vectors is given by:

(16) $\cos \phi = \frac{F \cdot U}{|F|\ |U|},$

where

(17) $F \cdot U = f_x u_x + f_y u_y + f_z u_z,$

and where $|F|$ and $|U|$ are the magnitudes of the vectors F and U, respectively.

The magnitude of the projection of U on F follows from:

(18) $|U_F| = |U| \cos \phi,$

that is,

(19) $|U_F| = \frac{F \cdot U}{|F|}$.

Since $|U_F| = u_f$, and $|F| = f$, we have:

(20) $z = u_f/f = \frac{F \cdot U}{|F|^2} = \frac{F \cdot U}{f^2}$;

substituting (17) in (20) yields:

(21) $z = \frac{f_x u_x + f_y u_y + f_z u_z}{f^2}$.

We also have:

(22) $z_x = u_x/f_x$; $u_x = f_x z_x$

(23) $z_y = u_y/f_y$; $u_y = f_y z_y$

(24) $z_z = u_z/f_z$; $u_z = f_z z_z$,

and from (11) we know that

(25) $f_x = f_z = k_{fy} = \frac{k}{\sqrt{1 + 2k^2}} f$.

Substituting (22) - (24) in (21) gives:

(26) $z = \frac{f_x^2 z_x + f_y^2 z_y + f_z^2 z_z}{f^2}$;

and applying (25) yields:

(27) $z = u_f/f = \frac{1}{1 + 2k^2} [k^2(z_x + z_z) + z_y]$,

which expression states the total mobility of the stapedial complex as a function of the partial mobilities of this complex, and of the position of the axis of rotation of malleus-incus. It now only remains to insert the values of the partial mobilities determined above.

Introducing from equation (12) the quantity z'_x:

$$(28) \quad z'_x = z_{st} \,||\, \frac{1}{2} z_\ell \,||\, z_{sh} \,||\, 2 z_c,$$

z_x and z_z are expressed as follows:

$$(29) \quad z_x = z_{sj} + z'_x$$

$$(30) \quad z_z = \frac{1}{2} [z_{sj} \,||\, z'_x].$$

In these terms, u_f/f appears as:

$$(31) \quad \begin{aligned} z &= u_f/f = \frac{1}{1 + 2k^2} \{k^2 [z_{sj} + z'_x + \frac{1}{2} (z_{sj} \,||\, z'_x)] + 8 z_{sh}\}, \\ z'_x &= z_{st} \,||\, \frac{1}{2} z_\ell \,||\, z_{sh} \,||\, 2 z_c. \end{aligned}$$

The corresponding expression for the impedance of the stapedial complex is:

$$(32) \quad \begin{aligned} Z &= f/u_f = (1 + 2k^2)\{\frac{1}{k^2} [Z_{sj} \,||\, Z'_x \,||\, 2 (Z_{sj} + Z'_x)] \,||\, \frac{1}{8} Z_{sh}\} \\ Z'_x &= Z_{st} + 2Z_\ell + Z_{sh} + \frac{1}{2} Z_c, \end{aligned}$$

where Z_{sj}, etc., indicates the impedance of the element denoted by the index.

Transmission u_c/f of stapedial complex

The transmission of the stapedial complex will be defined as the ratio of the velocity u_c of the midpoint of the footplate to the applied force f. The velocity u_c equals the sum of the partial velocities u_{cx}, u_{cy}, and u_{cz} due to the component forces f_x, f_y, and f_z. Of these partial velocities, u_{cy} equals zero because of the symmetrical suspension of the footplate around the long axis.

Referring to Fig. 19, and denoting by u_T the velocity of the top of stapes T, we have:

(33) $u_{cx} = u_{Tz} = \frac{1}{2} u_{Tx}$.

It remains to determine u_{cx}, or u_{Tx}, as a function of f_x. Figure 22 gives

Insert Fig. 22 about here

an equivalent diagram of the situation. The force f_x attacks the incudo-stapedial joint, and is transmitted through the mobility z_{sj} of this joint to the top of stapes, T. u_x and u_{Tx} denote the resulting velocities of the point of attack of the force f_x (i.e., the tip of the long process of incus) and of the top of stapes, respectively. It follows from this diagram that

(34) $u_{Tx}/f'_x = z'_x$

(35) $u_x/f_x = z'_x + z_{sj}$

and

(36) $(u_x - u_{Tx})/(f_x + f'_x) = z_{sj}$.

From these three equations in combination with equation (33) we obtain:

$$(37)\quad u_{cx} = \frac{1}{2}\frac{z_x'^2}{z_x' + z_{sj}} f_x.$$

The determination of u_{cz} follows directly from Fig. 20. We have:

$$(38)\quad u_{cz} = u_{Tz},$$

and from (30):

$$(39)\quad u_{Tz}/f_z = z_z = \frac{1}{2}[z_{sj} \,||\, z_x'],$$

that is,

$$(40)\quad u_{cz} = \frac{1}{2}[z_{sj} \,||\, z_x'] f_z.$$

From equation (11) we know that

$$(41)\quad f_x = f_z = \frac{k}{\sqrt{1 + 2k^2}} f.$$

We thus obtain:

$$(42)\quad u_c = u_{cx} + u_{cz} = \frac{k}{\sqrt{1 + 2k^2}}\left\{\frac{1}{2}\frac{z_x'^2}{z_x' + z_{sj}} + \frac{1}{2}[z_x' \,||\, z_{sj}]\right\} f.$$

Since

$$(43)\quad \frac{z_x'^2}{z_x' + z_{sj}} + (z_x' \,||\, z_{sj}) = \frac{z_x'^2}{z_x' + z_{sj}} + \frac{z_x' z_{sj}}{z_x' + z_{sj}} = \frac{z_x'(z_x' + z_{sj})}{z_x' + z_{sj}} = z_x',$$

is reduced to:

$$(44)\quad u_c = \frac{1}{2}\frac{k}{\sqrt{1 + 2k^2}} z_x' f,$$

or

(45) $$u_c = \frac{1}{2}\frac{k}{\sqrt{1 + 2k^2}}[z_{st} \mid\mid \frac{1}{2} z_\ell \mid\mid z_{sh} \mid\mid 2\, z_c]\, f.$$

In terms of impedances, the transmission is expressed as:

(46) $$f/u_c = \frac{2\sqrt{1 + 2k^2}}{k}(Z_{st} + 2Z_\ell + Z_{sh} + \frac{1}{2} Z_c).$$

We note from expressions (45) and (46) that the transmission of the stapedial complex is independent of the mobility z_{sj} (or the impedance Z_{sj}) of the incudo-stapedial joint.

Equivalent electrical networks

The equivalent electrical networks for the input impedance of the stapedial complex have already been given in Figs. 13 and 14.

The transmission of the stapedial complex is not directly recoverable from the networks just mentioned. Figure 23 shows an electrical network representing

Insert Fig. 23 about here

this transmission u_c/f in terms of the ratio of the current through the circuit to the applied voltage. (As was the case for the impedance network, we have set $Z_x = Z_{st} + 2Z_\ell + \frac{1}{2} Z_c$). While the input impedance of the extended analog is determined as the input impedance of Zwislocki's network of Fig. 10 with its two last branches substituted by the network of Fig. 14, the total transmission of the extended analog cannot be determined by substituting the network of Fig. 23 for the last two branches of Zwislocki's network. The reason is that the transmission network must be fed with a voltage representing the force applied to the incudo-stapedial joint, that is, the voltage existing at the junction between Zwislocki's network and the network of Fig. 14. Since the input impedance of the transmission network is totally different from the network of Fig. 14, this condition would not be met by coupling the transmission network to Zwislocki's network. Therefore, the voltage representing the force applied to the incudo-stapedial joint must be determined separately, and then applied to the transmission network for a determination of the ratio f_{input}/u_c.

Since the impedance of the stapedial network is a function of the mobility z_{sj} of the incudo-stapedial joint, we notice that although the transmission of the stapedial complex alone is independent of z_{sj}, the total transmission of the extended analog will depend on this mobility.

Footnote

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Table 1

Subject	JR			LL				FP			
Transition	1-2	2-3	3-4	1-2	2-3	3-4	4-5	1-2	2-3	3-4	4-5
Contour	eq.1.	st.displ.	st.displ.	eq.1.	st.displ.	st.displ.	st.displ.	eq.1.	st.displ.	st.displ.	st.displ.
Signature	o	◊	□	o	◊	□	Δ	o	◊	□	Δ
f											
20	-	121	129	-	104	117	142	-	113	119	141
32	(133.5)	121	129	131.5	104	117	142	(130.5)	113.5	119.5	141.5
50	128	121.5	129.5	117	104.5	117.5	142.5	123.5	114	120	142
80	121	122	130	108	105	118	143	115	114.5	120.5	142.5
125	112	122	130	100	105.5	118.5	143.5	108	115	121	143
200	104.5	121.5	129.5	93	106	119	144	101	116	122	144
320	99	121	129	86.5	107	120	145	100	116.5	122.5	144.5
500	95	120.5	128.5	89.5	108	121	146	98	118.5	124.5	146.5
800	96.5	119	127	84.5	110	123	148	102.5	121.5	127.5	149.5
1250	-	-	-	-	-	-	-	102	126	132	154

Predicted thresholds for various stages of impedance change. All entries in db SPL.

Table 2

Parameter	Z.'s analog	Ext. analog	Parameter	Z.'s analog	Ext. analog
L_a	30	30	C_x	-	.40
L_{d2}	15	25	C_{sh}	-	.25
L_o	25	50	C_{sj}	-	.25
L_c	40	-	R_a	10	10
L_x	-	40	R_m	850	1000
C_p	3.8	2.0	R_{d1}	40	40
C_t	.35	.35	R_{d2}	220	220
C_{d1}	.28	.28	R_o	140	35
C_{d2}	.40	.40	R_s	2000	-
C_o	.70	2.8	R_c	750	-
C_s	.25	-	R_x	-	750
C_c	2.4	-	R_{sh}	-	2000
			R_{sj}	-	50

Parameter values for initial adjustment of Zwislocki's analog network and for extended analog network, for S LL. Inductances are given in millihenries, capacitances in microfarads, and resistances in ohms.

Figure Captions

Fig. 1. Average acoustic impedance at the eardrum for varying intensity of the stimulating tone, with frequency as parameter. Arrows on lines connecting impedance values indicate increasing intensity of stimulating tone. (Data for 80 cps omitted for clarity). Data for S JR.

Fig. 2. As Fig. 1, data for S LL.

Fig. 3. As Fig. 1. Resistance values for 320 cps and 800 cps have been multiplied by factors of 2.0 and 2.5, respectively. Data for S FP.

Fig. 4. Average acoustic resistance at the eardrum as a function of sound pressure level of the stimulating tone, with frequency of stimulating tone as parameter. Circles represent an equal-loudness contour, and squares an (approximate) contour of equal displacement amplitude of stapes. Data for S JR.

Fig. 5. Average acoustic reactance at the eardrum as a function of sound pressure level of the stimulating tone, with frequency of stimulating tone as parameter. Circles represent the same equal-loudness contour as plotted in Fig. 4, and diamonds represent an (approximate) contour of equal displacement amplitude of stapes, (different from the one plotted in Fig. 4). Data for S JR.

Fig. 6. As Fig. 4, except that data points for 80, 125, 200, 320, 500, and 800 cps have been multiplied by 1.1, 1.1, 1.2, 1.3, 1.2, and .7, respectively, for better separation. Data for S LL.

Fig. 7. As Fig. 5, data for S LL.

Fig. 8. As Fig. 4, except that data points for 125, 320, 500, 800, and 1250 cps have been multiplied by 1.2, .85, .65, .50, and .48, respectively,

for better separation. Data for S FP.

Fig. 9. As Fig. 5, data for S FP.

Fig. 10. Zwislocki's (1962) impedance analogy of the middle ear. Subscripts a, p, m, and t refer to the middle-ear cavities; d_1 and d_2 to the eardrum; and o, s, and c to the malleo-incudal complex, the incudo-stapedial joint, and the cochlear complex, respectively.

Fig. 11. Effect on input impedance of Zwislocki's analog network for S JR of isolated variation of C_{d_1}, C_o, C_s, and C_c. Arrows on lines connecting impedance values for a given frequency indicate increasing values of the parameter in question.

Fig. 12. Effect on input impedance of Zwislocki's analog network for S LL of isolated variation of C_{d_1}, C_o, C_s, and C_c, and simultaneous variation of C_{d_1} and C_o. Arrows on lines connecting impedance values for a given frequency indicate increasing values of the parameter in question.

Fig. 13. Extended analog network for the stapedio-cochlear complex, as developed in the Appendix. Subscript st denotes stapedius; ℓ - anterior ligaments of stapes footplate; sh - ligaments of footplate at ends of short axis; c - cochlear complex; sj - incudo-stapedial joint. k is a measure of displacement of axis of rotation of malleo-incudal complex.

Fig. 14. Electrical equivalent of the network of Fig. 13, where $Z_x = Z_{st} + 2Z_\ell + \frac{1}{2}Z_c$.

Fig. 15. Broken lines: Average acoustic impedance at the eardrum for varying intensity of the stimulating tone, with frequency as parameter (replicated from Fig. 2). Full lines: Effect on input impedance of extended analog network of first increasing value of C_{d_1}, and then decreasing value of k. Data for S LL.

Fig. 16. Diagrams of spatial specifications for incudo-stapedial complex. T - top of stapes; C - tip of short process of incus; a - normal axis of rotation of malleus-incus; 0 - center of oval window; AB - long axis of stapes footplate; DE - short axis of stapes footplate; ℓ = AB; G - center of gravity of malleo-incudal complex.

Fig. 17. Geometry of vibratory plane, and decomposition of normal force. T - top of stapes; C - tip of short process of incus; F - projection of C on the xz-plane; f - normal force.

Fig. 18. Component forces attacking the top of stapes as a function of position of axis of rotation of malleo-incudal complex, displayed in the vibratory plane. T, C, F - as Fig. 17; R - projection of axis of rotation on FC.

Fig. 19. Diagram of the xz-plane through the top of stapes (T) for determining the mobility z'_x of this point in the x-direction. F_x - x-component of force attacking T; z_ℓ - mobility of long ligaments at anterior end of stapes footplate; z_k - mobility of midpoint of footplate; z_{st} - mobility of stapedius; z_{sj} - mobility of incudo-stapedial joint.

Fig. 20. Diagram of the xz-plane through the top of stapes (T) for determining the mobility z_z of this point in the z-direction. Symbols as for Fig. 19.

Fig. 21. Diagram of the yz-plane through the top of stapes (T) for determining the mobility z_y of this point in the y-direction. z_{sh} - mobility of the short ligaments of stapes footplate.

Fig. 22. Diagram for determining the velocity u_{Tx} of the top of stapes in the x-direction as a function of the force f_x attacking the incudo-stapedial

joint. z_{sj} - mobility of incudo-stapedial joint; z_x' - mobility of top of stapes in the x-direction; u_x - velocity of point of attack of f_x; u_{Tx} - velocity of T.

Fig. 23. Electrical equivalent for determining the transmission from tip of incus to cochlear fluid, according to equation (46). $Z_x = Z_{st} + 2Z_\ell + \frac{1}{2}Z_c$; k - measure of displacement of axis of rotation of malleo-incudal complex.

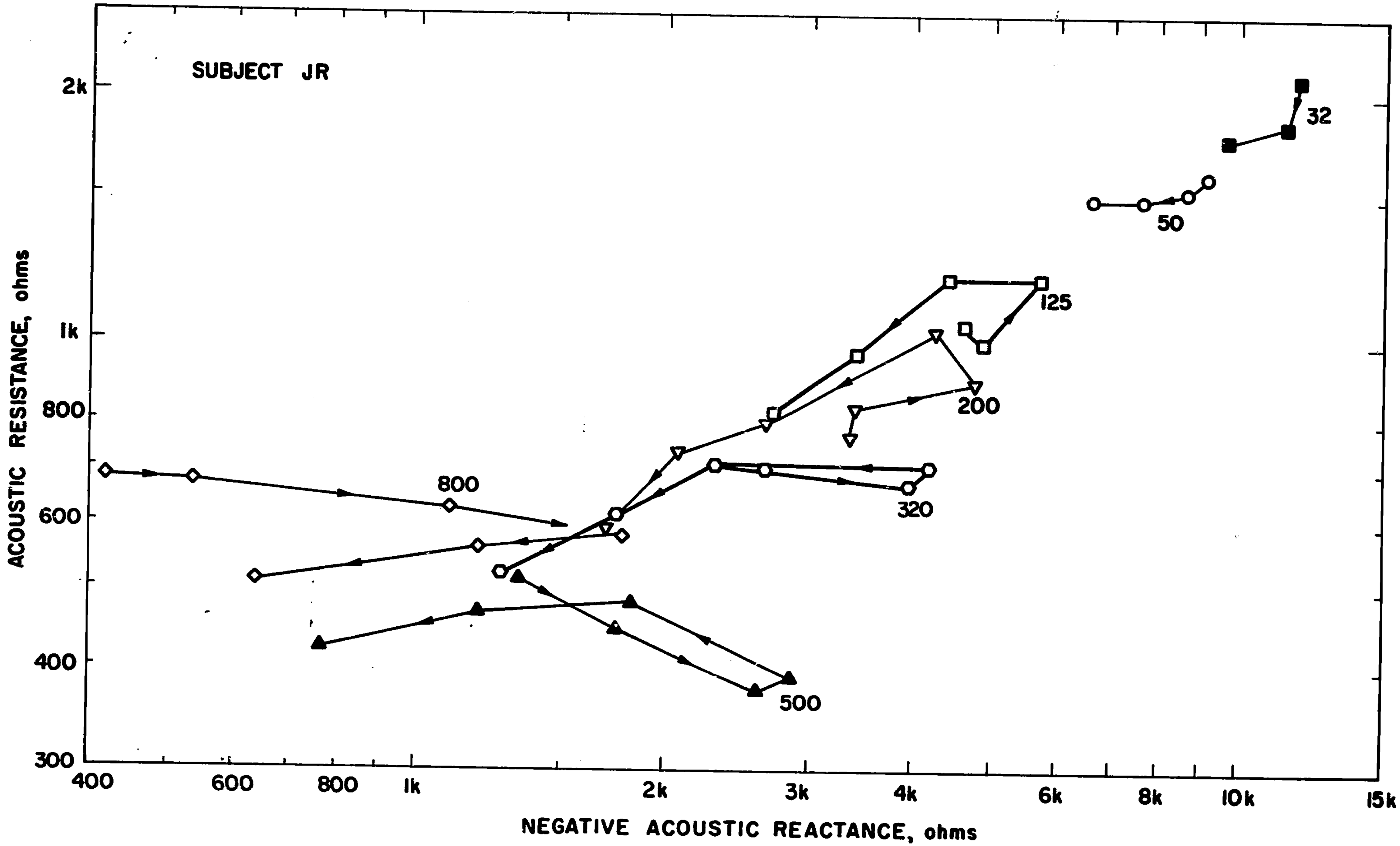
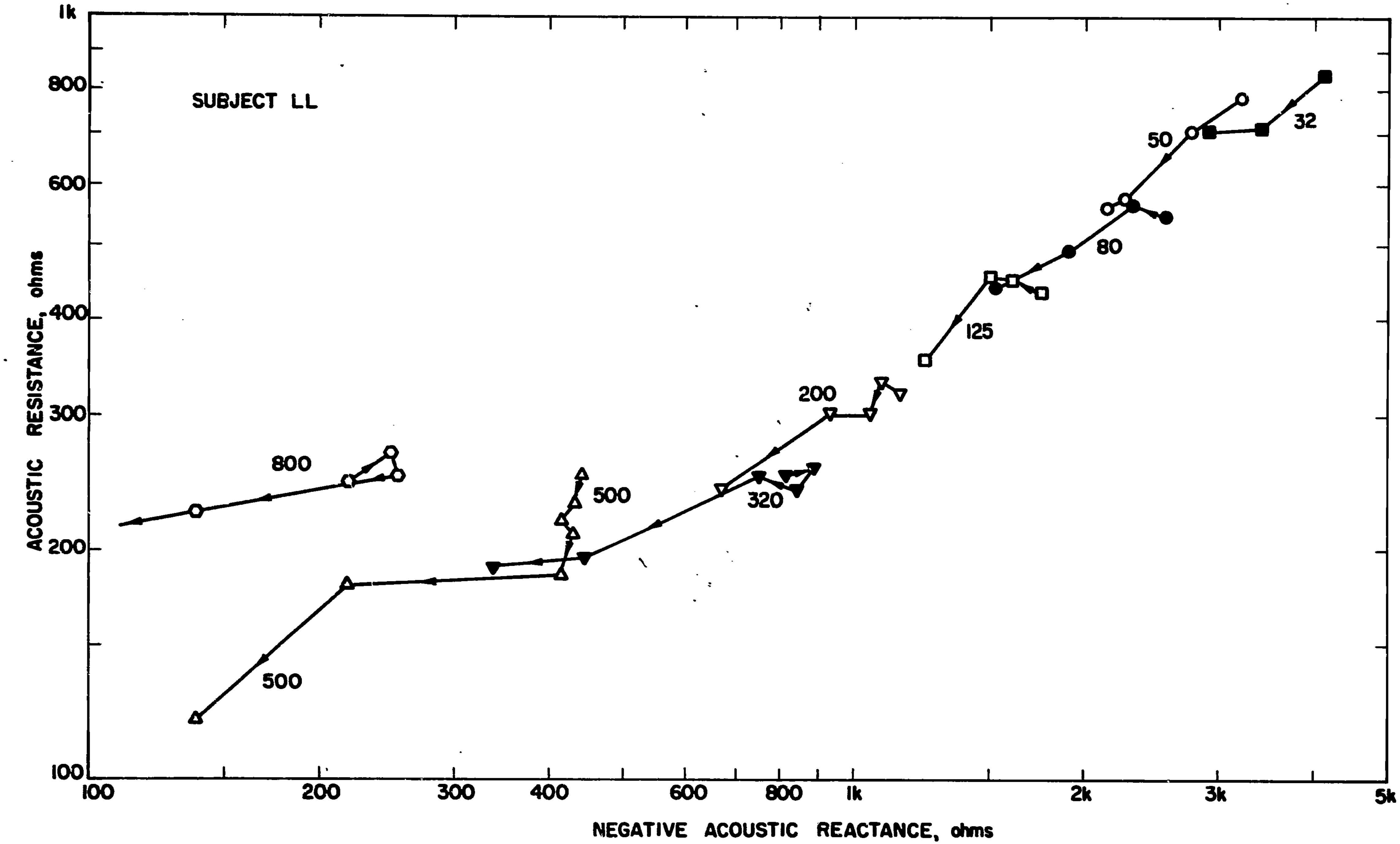
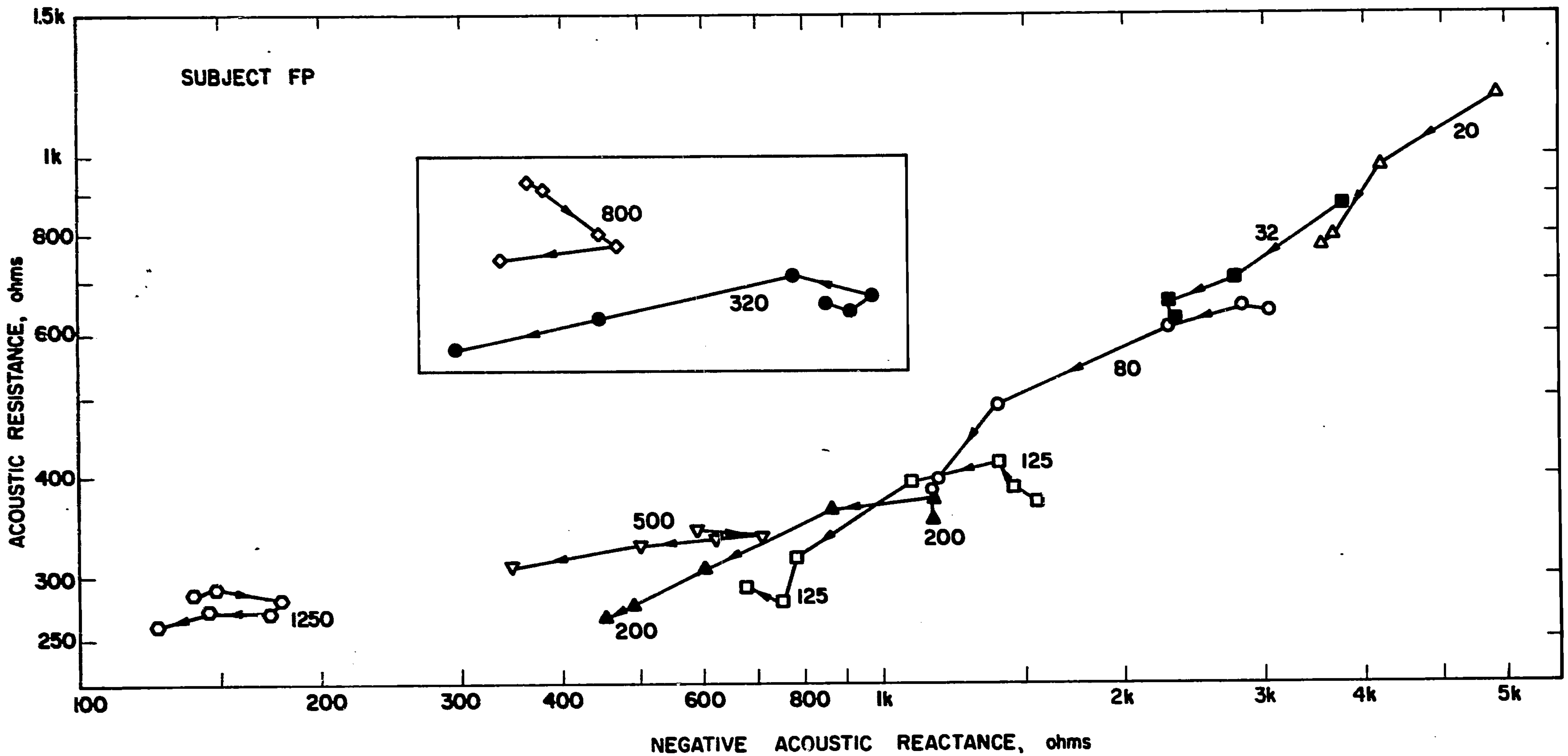

SUBJECT JR
2k
1k
800
600
400
300
400
600
800
1k
2k
3k
4k
6k
8k
10k
15k
32
50
125
200
320
800
500
ACOUSTIC RESISTANCE, ohms
NEGATIVE ACOUSTIC REACTANCE, ohms

Fig. 1



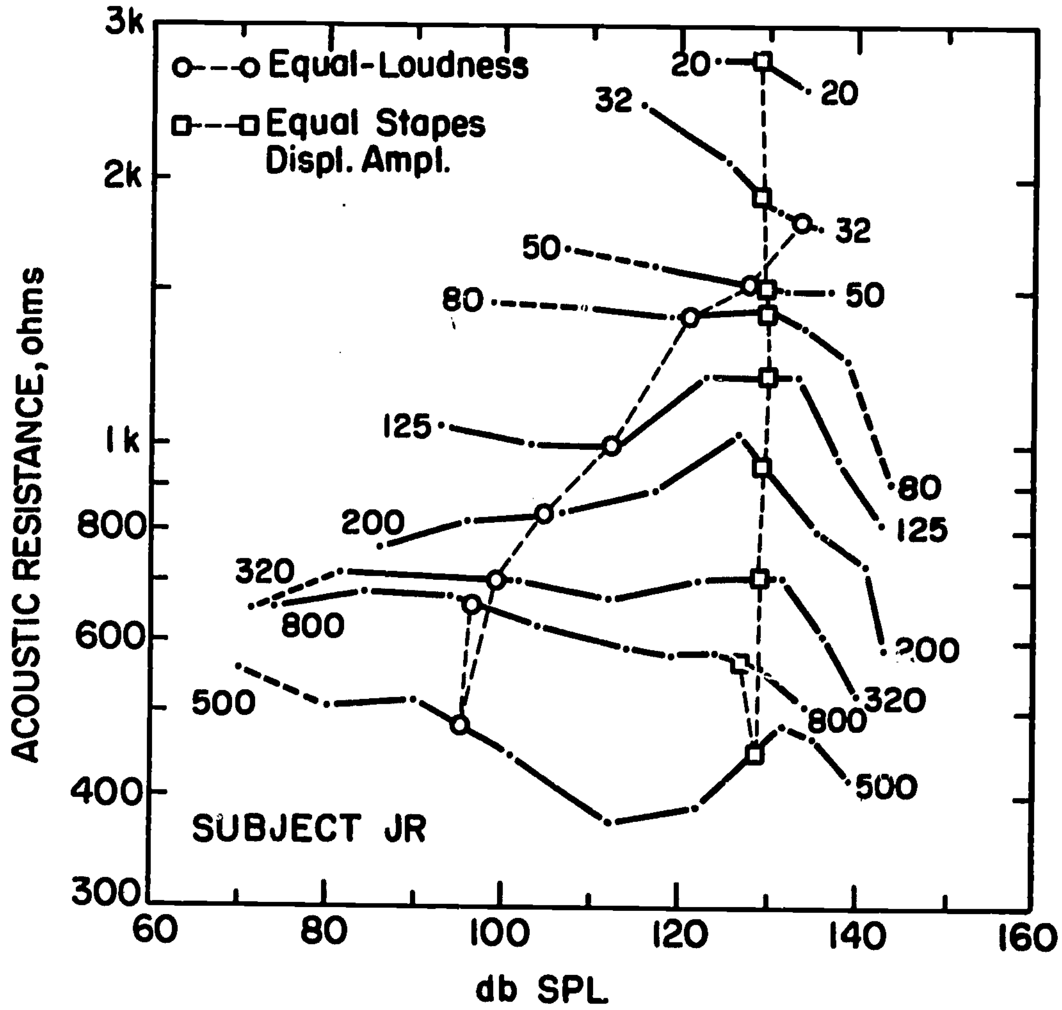
SUBJECT LL
800
500
500
320
200
125
80
50
32
ACOUSTIC RESISTANCE, ohms
1k
800
600
400
300
200
100
100
200
300
400
600
800
1k
2k
3k
5k
NEGATIVE ACOUSTIC REACTANCE, ohms

Fig. 2



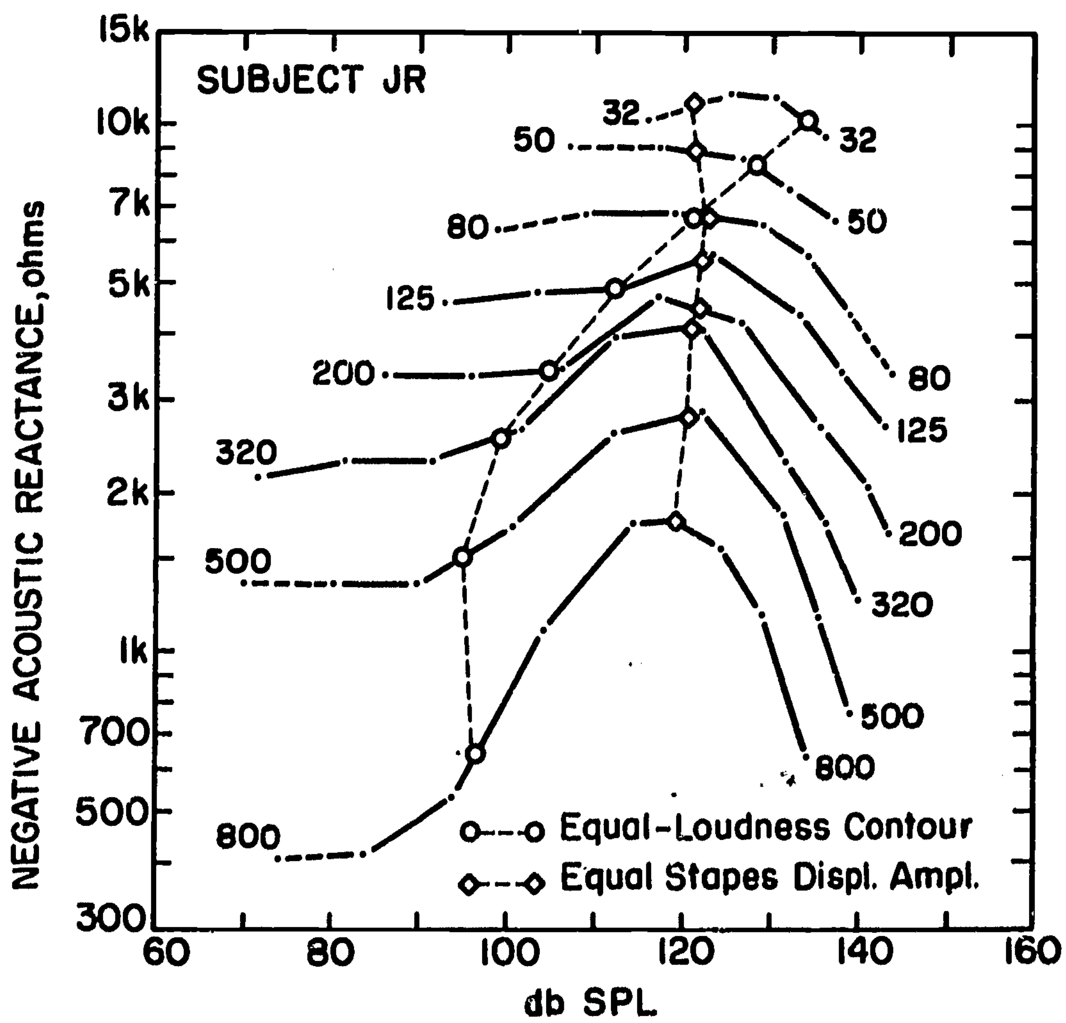
SUBJECT FP
ACOUSTIC RESISTANCE, ohms
NEGATIVE ACOUSTIC REACTANCE, ohms
1.5k
1k
800
600
400
300
250
100
200
300
400
600
800
1k
2k
3k
4k
5k
20
32
80
125
125
200
200
320
500
800
1250

Fig. 3



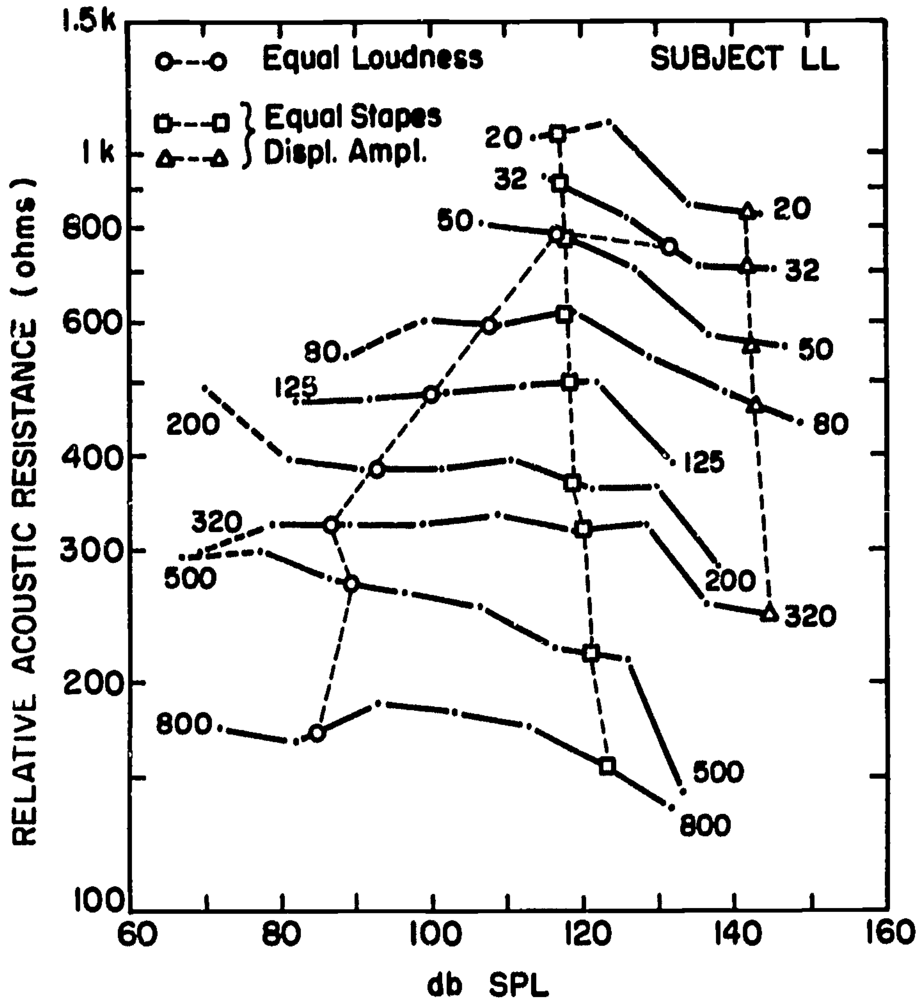
Equal-Loudness
Equal Stapes Displ. Ampl.
SUBJECT JR
ACOUSTIC RESISTANCE, ohms
db SPL
3k
2k
1k
800
600
400
300
60
80
100
120
140
160
20
32
50
80
125
200
320
800
500

Fig. 4



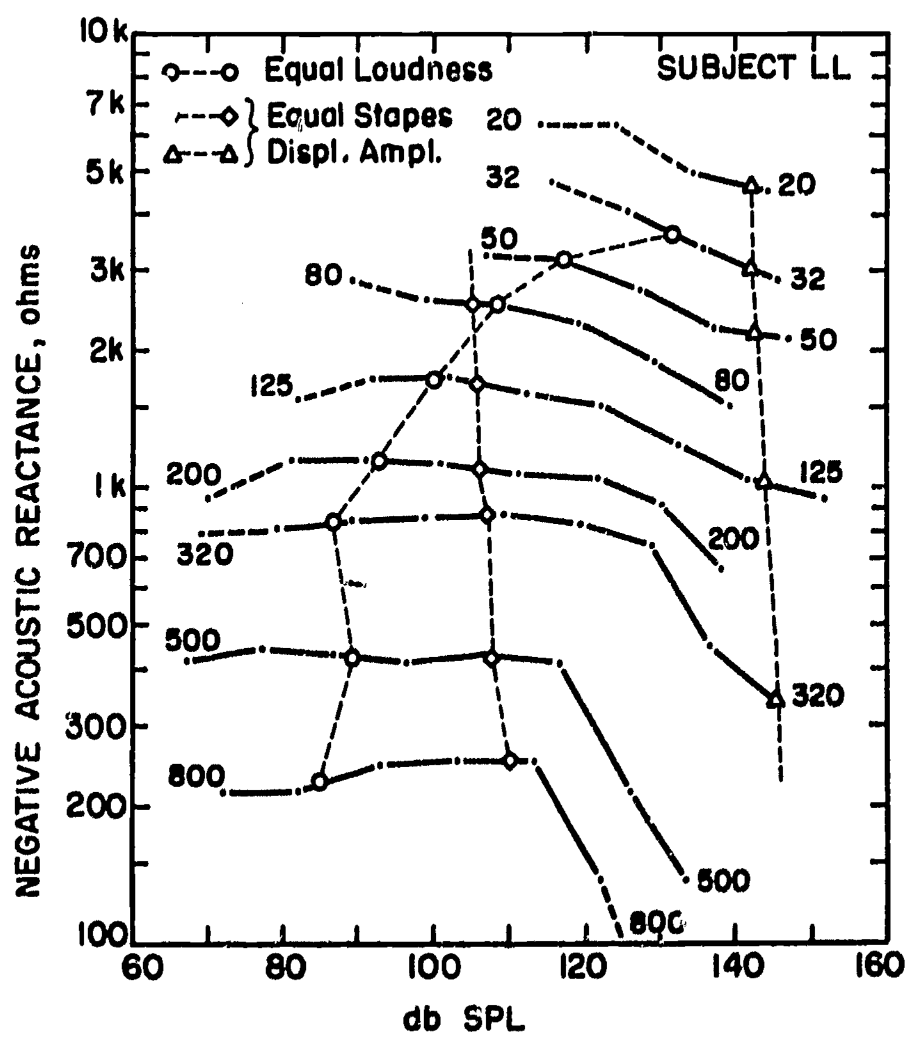
SUBJECT JR
Equal-Loudness Contour
Equal Stapes Displ. Ampl.
NEGATIVE ACOUSTIC REACTANCE, ohms
db SPL
15k
10k
7k
5k
3k
2k
1k
700
500
300
60
80
100
120
140
160
32
50
80
125
200
320
500
800

Fig. 5



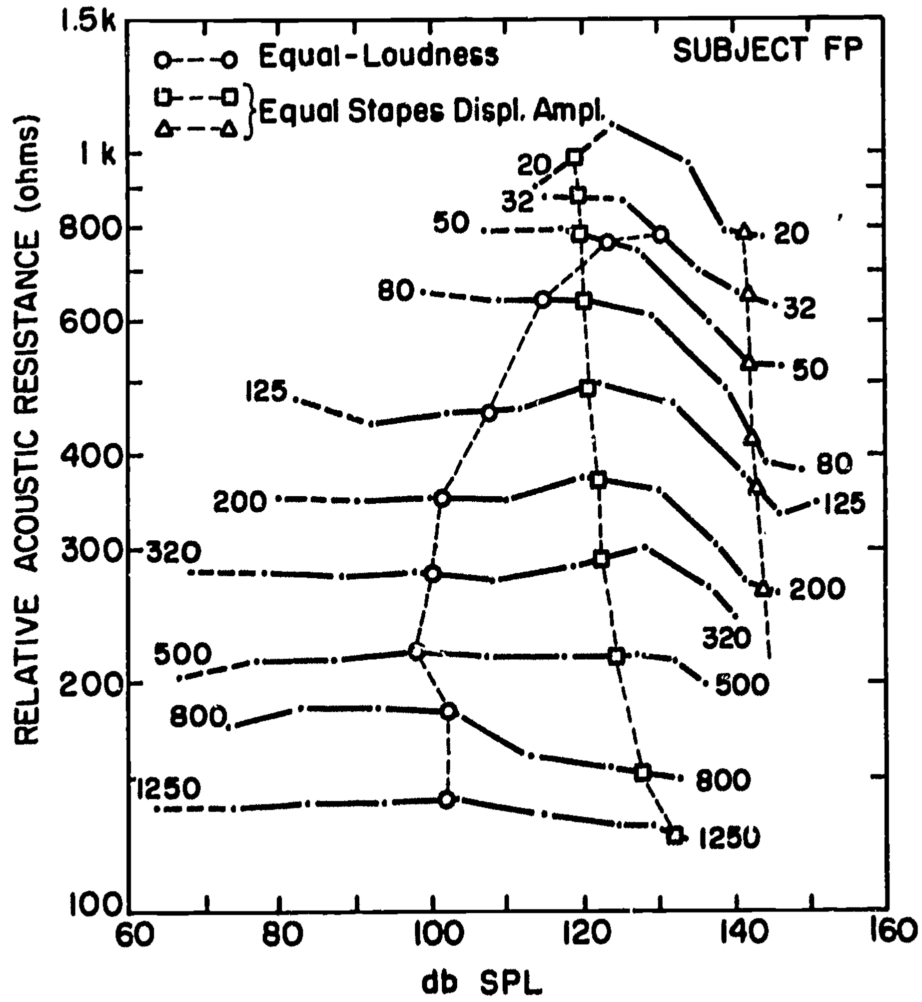
Equal Loudness
SUBJECT LL
Equal Stapes
Displ. Ampl.
RELATIVE ACOUSTIC RESISTANCE (ohms)
db SPL

Fig. 6



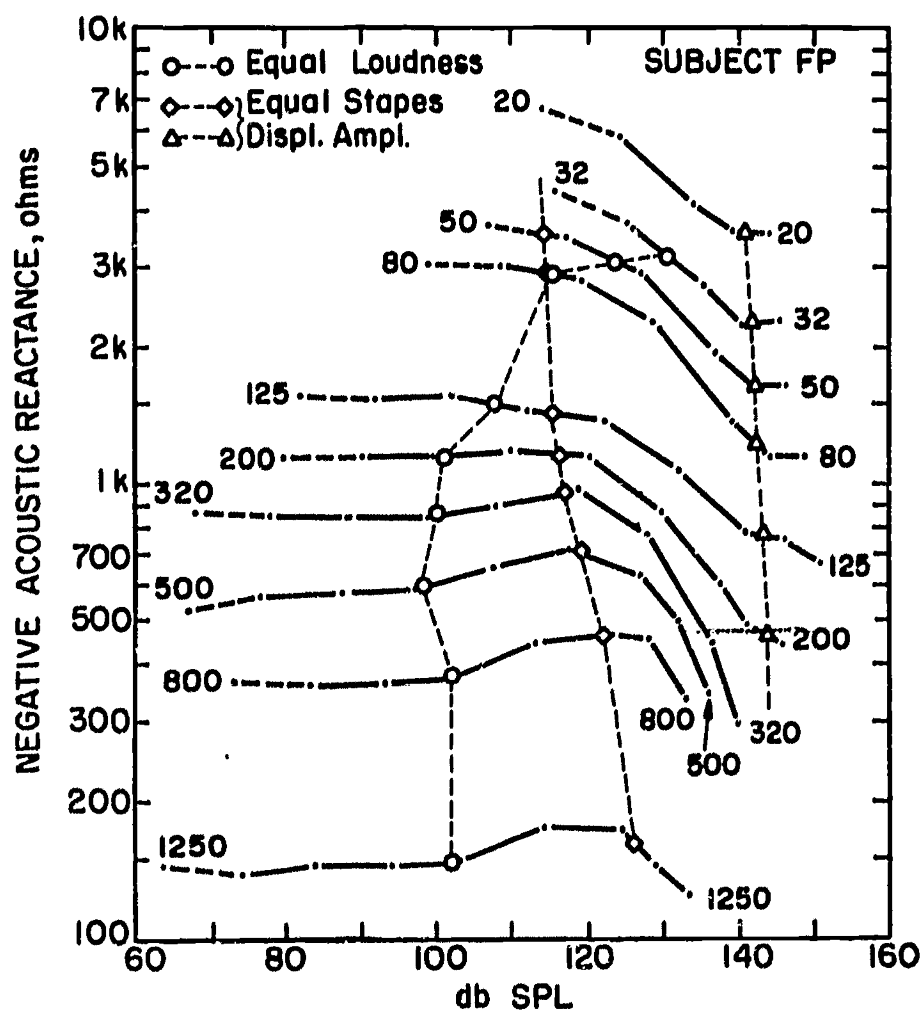
Equal Loudness
SUBJECT LL
Equal Stapes
Displ. Ampl.
NEGATIVE ACOUSTIC REACTANCE, ohms
db SPL

Fig. 7



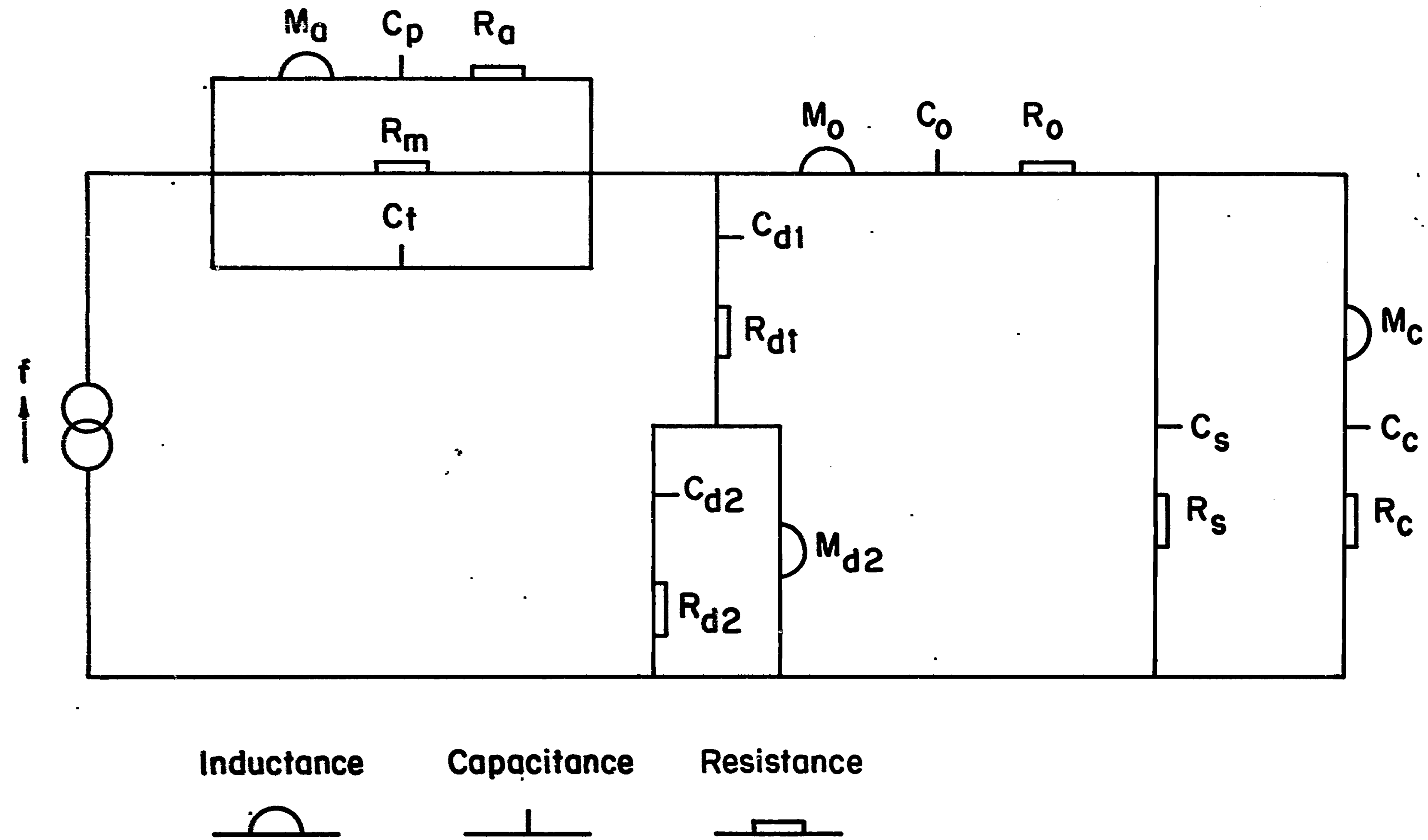
o---o Equal-Loudness
SUBJECT FP
Equal Stapes Displ. Ampl.
RELATIVE ACOUSTIC RESISTANCE (ohms)
1.5k
1 k
800
600
400
300
200
100
60
80
100
120
140
160
db SPL
20
32
50
80
125
200
320
500
800
1250

Fig. 8



o---o Equal Loudness
SUBJECT FP
Equal Stapes
Displ. Ampl.
NEGATIVE ACOUSTIC REACTANCE, ohms
10k
7k
5k
3k
2k
1k
700
500
300
200
100
60
80
100
120
140
160
db SPL
20
32
50
80
125
200
320
500
800
1250

Fig. 9



Ma
Cp
Ra
Rm
Ct
Mo
Co
Ro
Cd1
Rdt
Cd2
Md2
Rd2
Cs
Rs
Mc
Cc
Rc
f
Inductance
Capacitance
Resistance

Fig. 10

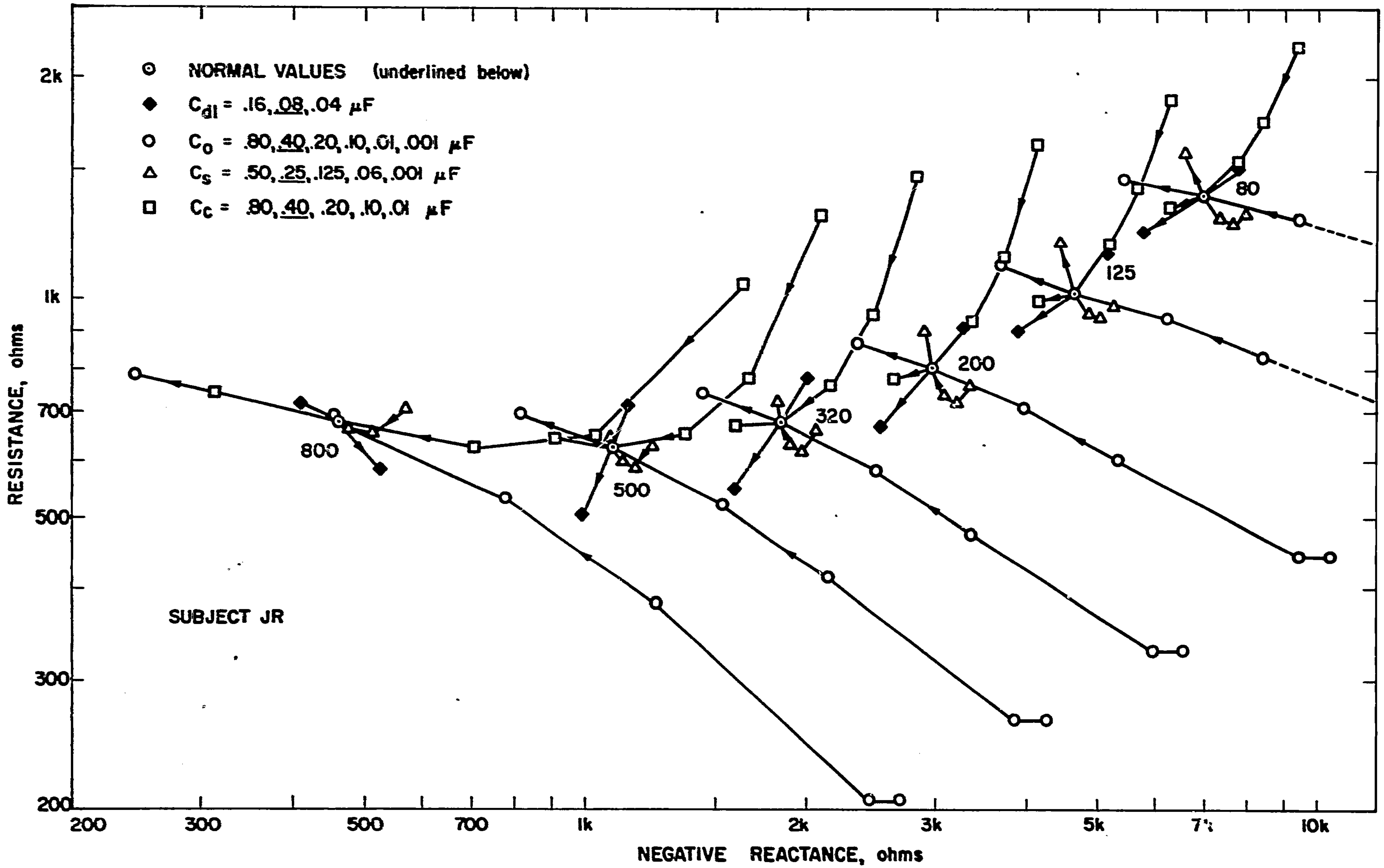

NORMAL VALUES (underlined below)
Cdl = .16, .08, .04 μF
Co = .80, .40, .20, .10, .01, .001 μF
Cs = .50, .25, .125, .06, .001 μF
Cc = .80, .40, .20, .10, .01 μF
SUBJECT JR
80
125
200
320
500
800
RESISTANCE, ohms
2k
1k
700
500
300
200
NEGATIVE REACTANCE, ohms
200
300
500
700
1k
2k
3k
5k
10k

Fig. 11

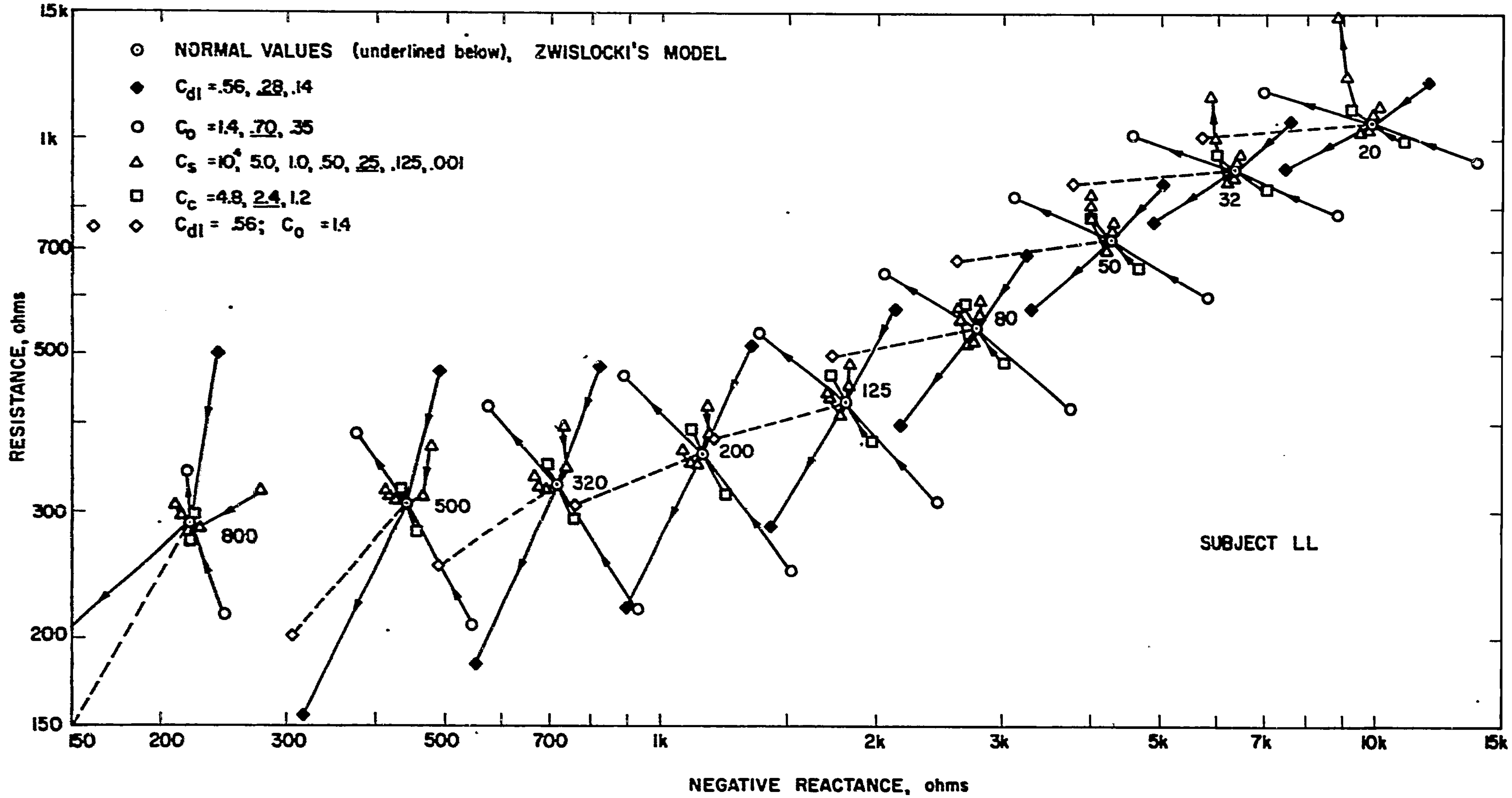
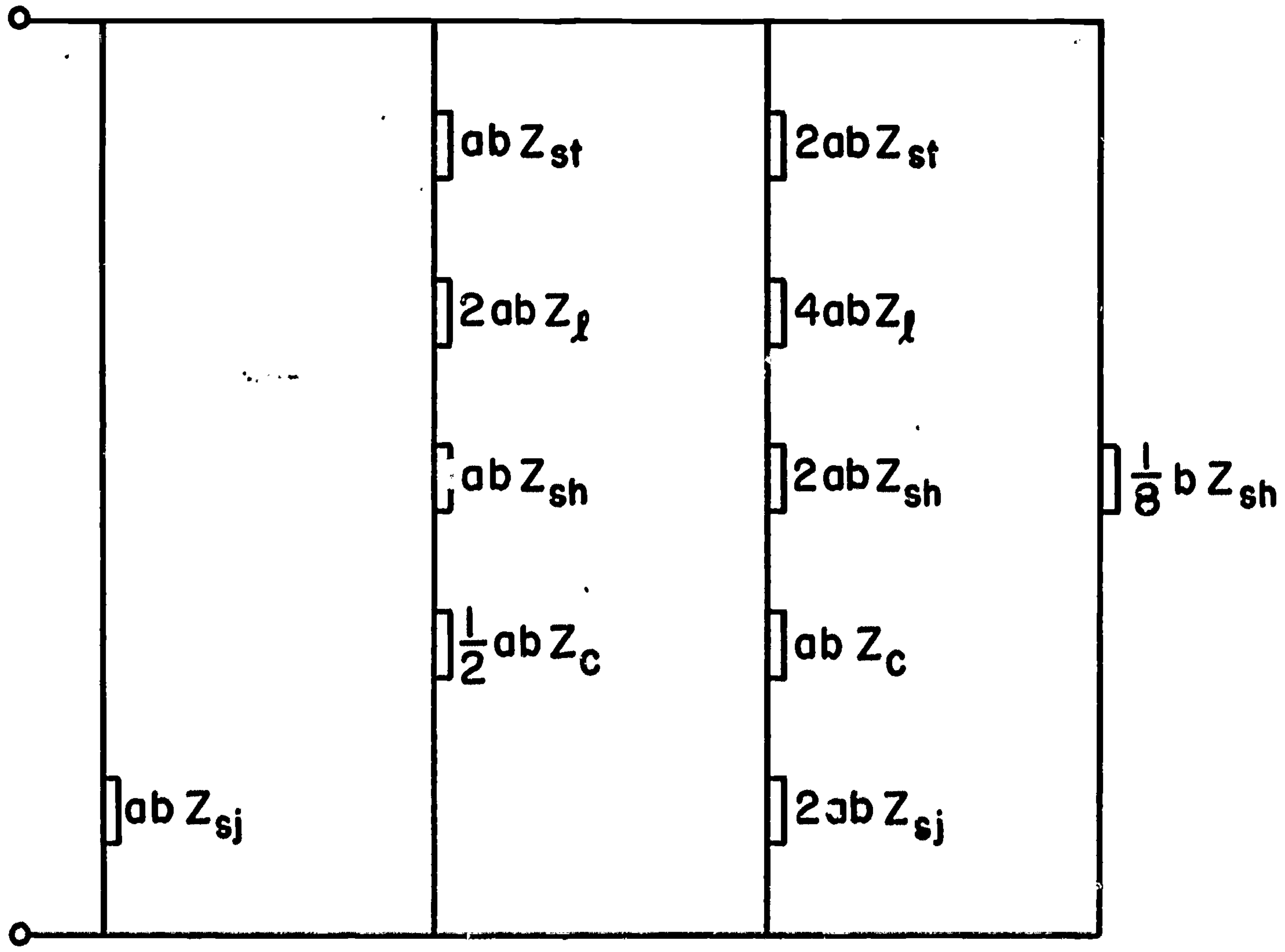
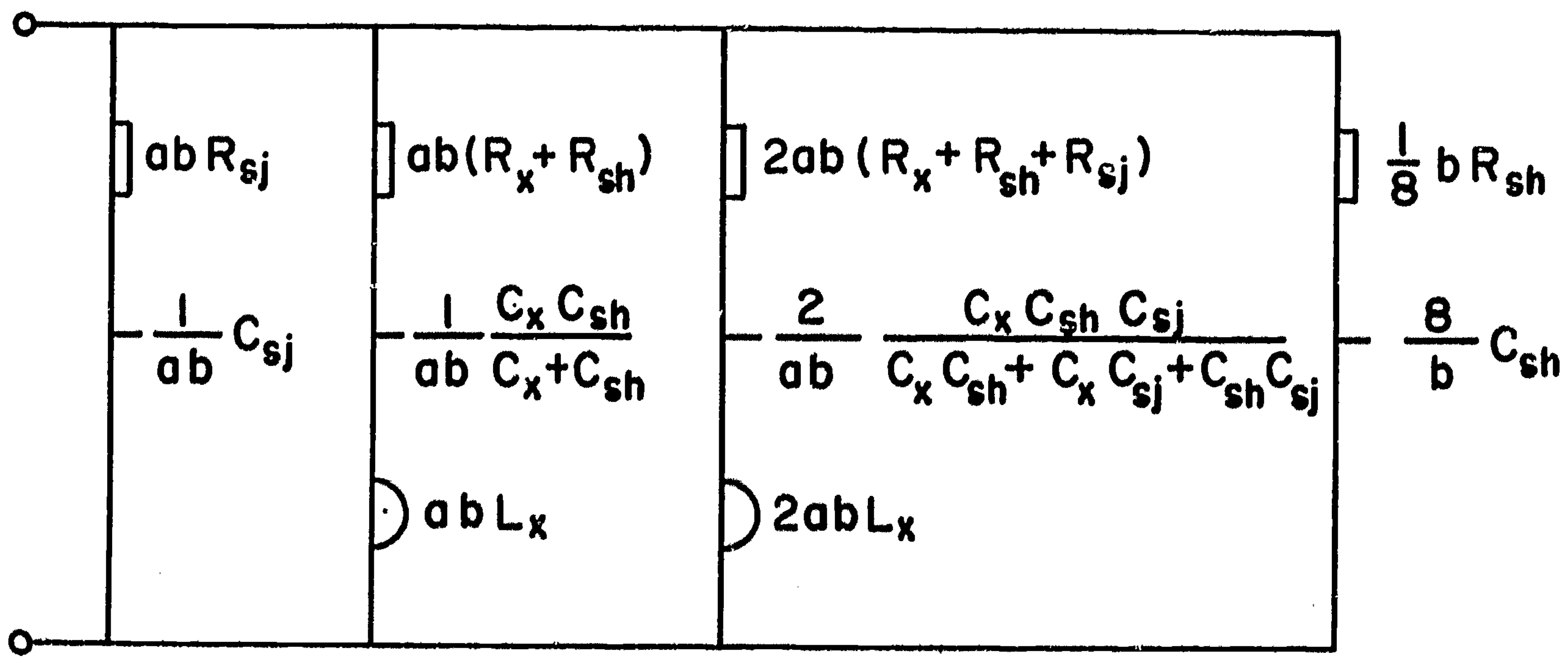

NORMAL VALUES (underlined below), ZWISLOCKI'S MODEL
C_{dl} =.56, .28, .14
C_o =1.4, .70, .35
C_s =10^4, 5.0, 1.0, .50, .25, .125, .001
C_c =4.8, 2.4, 1.2
C_{dl} = .56; C_o =1.4
SUBJECT LL
800
500
320
200
125
80
50
32
20
RESISTANCE, ohms
NEGATIVE REACTANCE, ohms
150
200
300
500
700
1k
2k
3k
5k
7k
10k
15k

Fig. 12



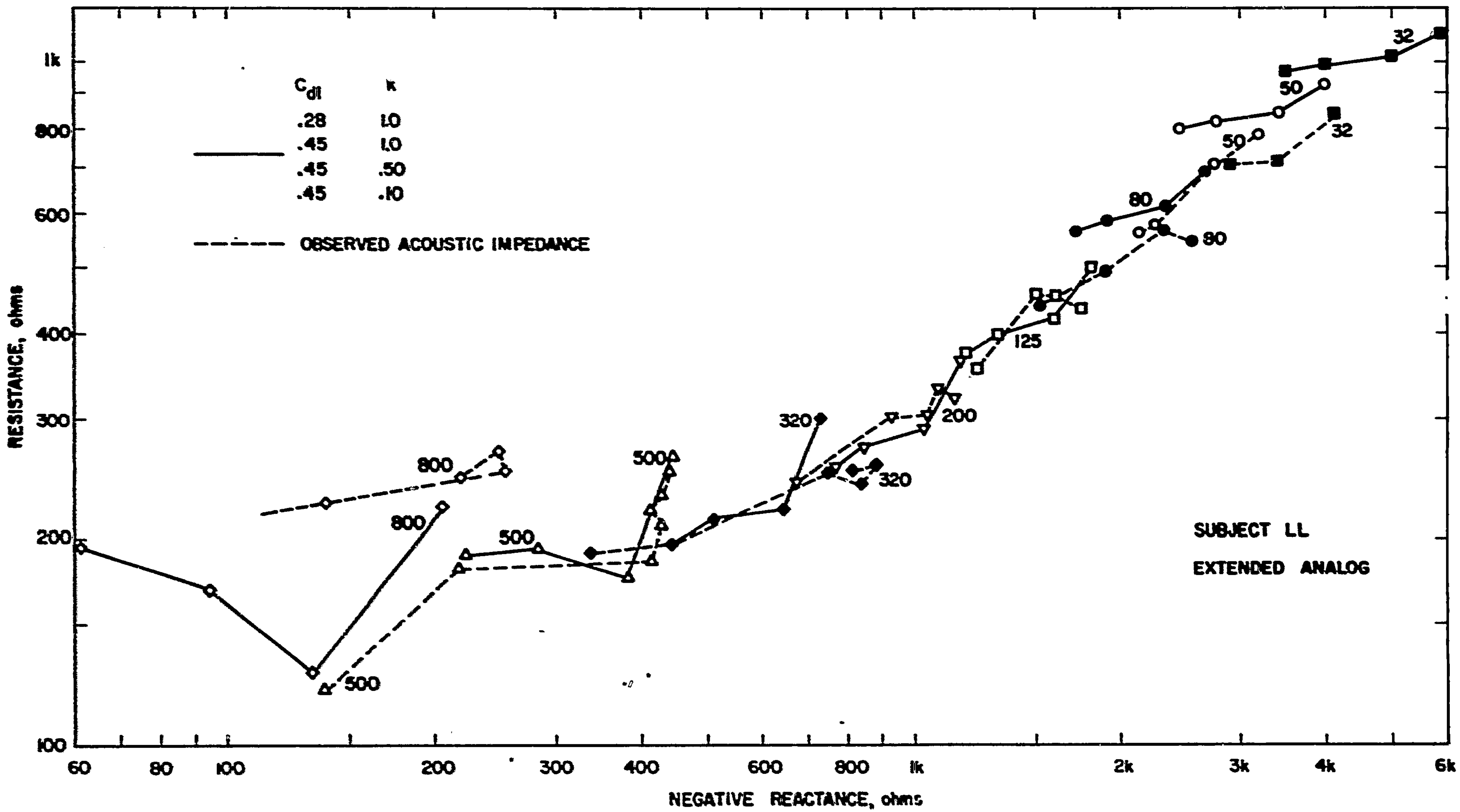
$$a = 1 + 2k^2 \qquad b = \frac{1}{k^2} \qquad 0 \leq k \leq 1$$

Fig. 13



$$a = 1 + 2k^2 \qquad b = \frac{1}{k^2} \qquad 0 \leq k \leq 1$$

Fig. 14



C_{dl} k
.28 1.0
.45 1.0
.45 .50
.45 .10
OBSERVED ACOUSTIC IMPEDANCE
SUBJECT LL
EXTENDED ANALOG
RESISTANCE, ohms
NEGATIVE REACTANCE, ohms

Fig. 15

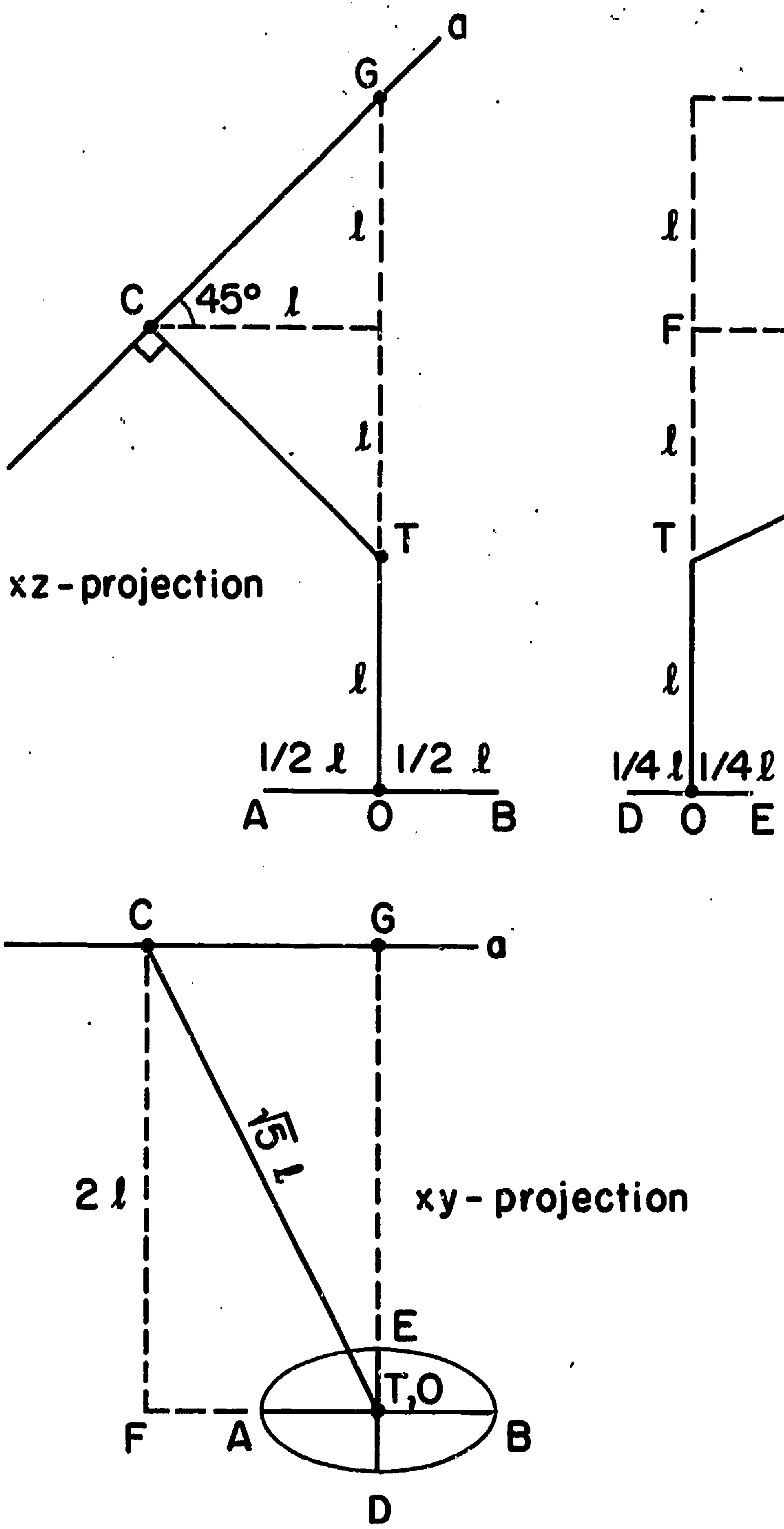

a
G
C
45°
ℓ
T
xz - projection
1/2 ℓ
1/2 ℓ
A
O
B
2ℓ
F
yz - projection
1/4 ℓ
1/4 ℓ
D
E
√5 ℓ
xy - projection
T,O

Fig. 16

2

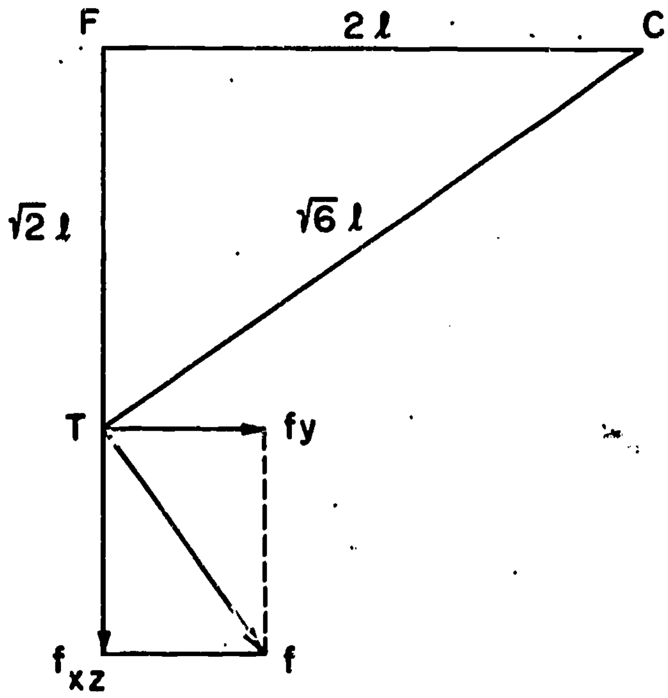


Fig. 17

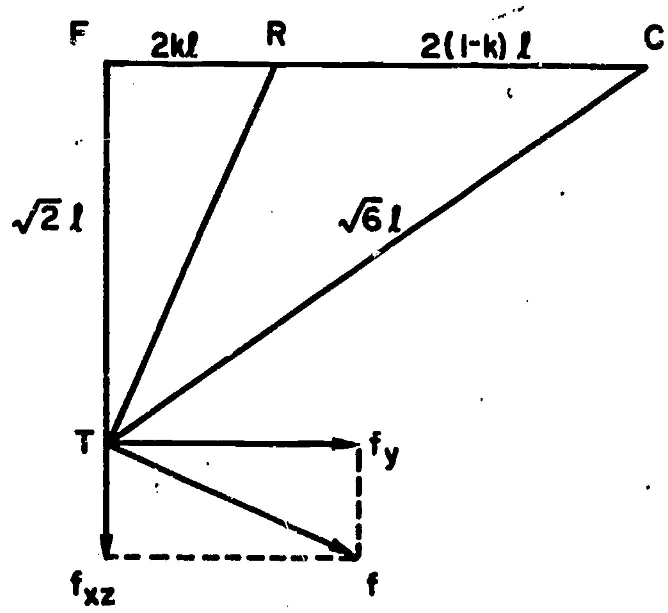


Fig. 18

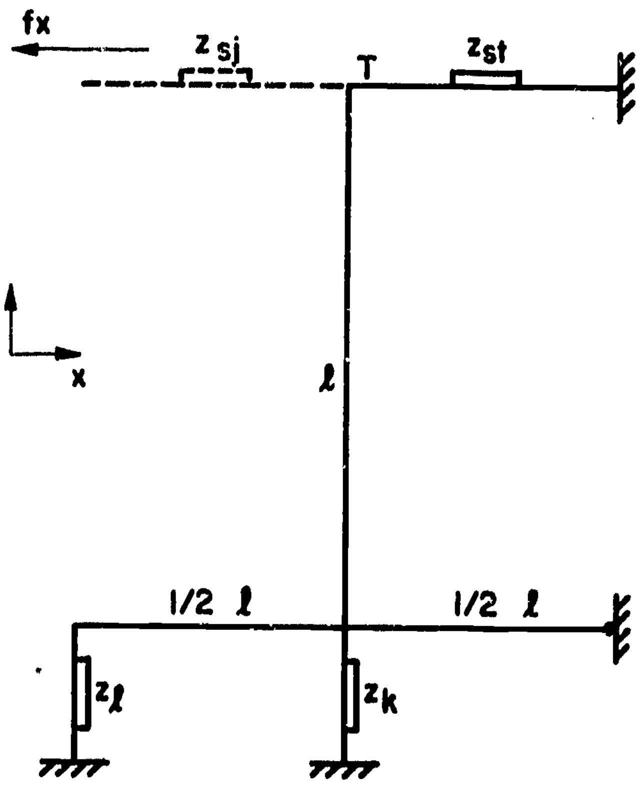


Fig. 19

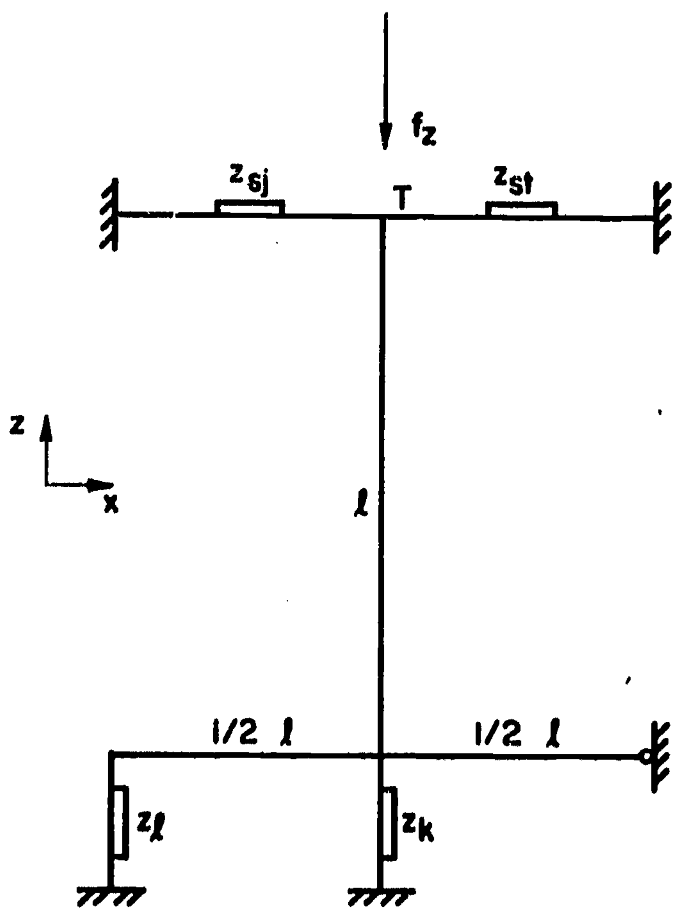


Fig. 20

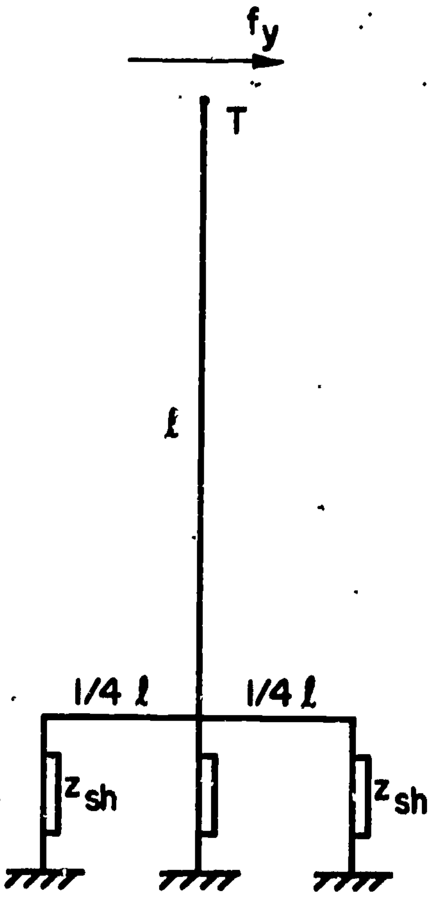


Fig. 21

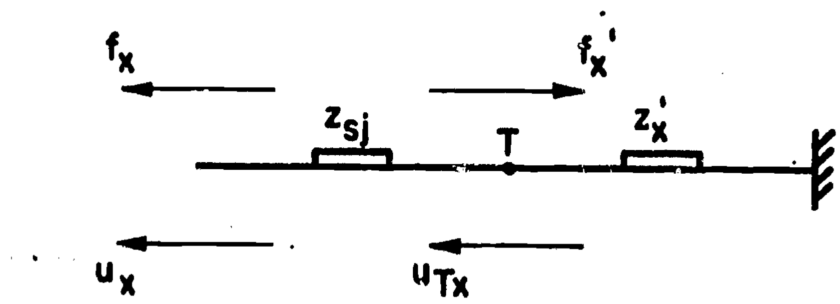


Fig. 22

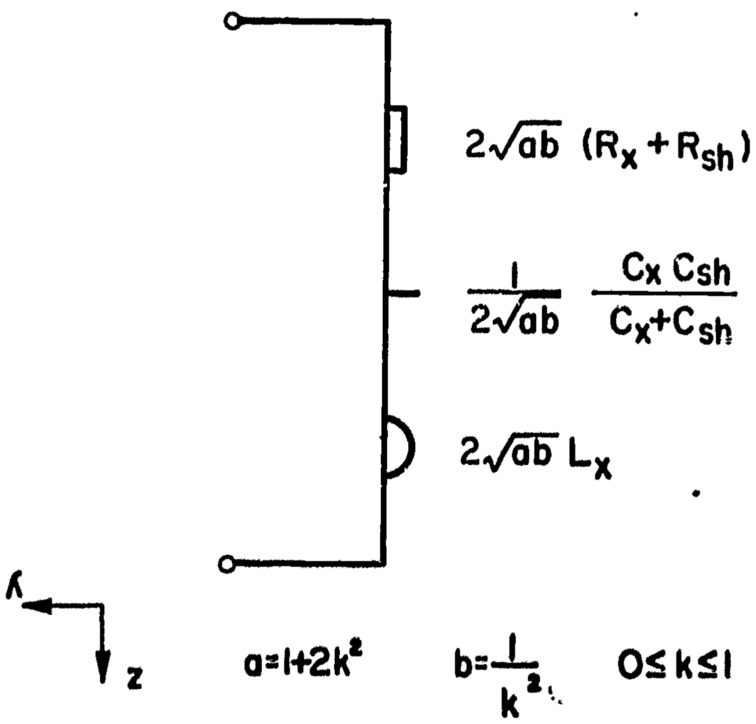


Fig. 23

Loudness of Pure Tones as a Function of Frequency, Intensity, and Middle-Ear Mechanics

Part IV

Review and Final Discussion

Equal-loudness contours

Previous research on equal-loudness contours has been utilized by Lochner and Burger (1962) for constructing an average set of equal-loudness contours (based on an intensity/loudness relation somewhat different from the one described in Part II). Figure 1 shows one of these equal-loudness contours, and the average threshold curve from the same study. Figure 1

Insert Fig. 1 about here

further shows the average thresholds and one set of average loudness matches for each of the three <u>Ss</u> employed in the present study. Keeping in mind that the thresholds compiled by Lochner and Burger are minimum audible field (MAF) data, while ours are minimum audible pressure (MAP) data, we should expect our threshold values to be somewhat higher for frequencies above 1000 cps, with a maximum departure of about 10 db at 4000 cps (Wiener, 1947; from Bekesy & Rosenblith, 1951). The somewhat greater departures in this frequency region may be due either to peculiarities of the <u>Ss</u> employed, to the technique of measuring the applied stimulus, or to the psycho-physical method employed. At lower frequencies the correspondence between the two sets of data is very satisfactory.

Disregarding frequencies above 1500 cps, where individual resonance phenomena are very likely to introduce great differences in the data, we notice from Fig. 1 that our equal-loudness data consistently show a sharper rise in intensity with decreasing frequency than the data of Lochner and Burger. (This holds true also when comparing our data with each of the sets of data employed by Lochner and Burger). This difference between the two sets of data will be even more apparent by comparing Fig. 2, in which

Insert Fig. 2 about here

the matching functions (relative to 320 cps), reconstructed from Lochner and Burger's data are given, with Figs. 23-25 of Part II. In our data the slopes of the matching functions are much closer to 1.0, and the characteristic curvature of the matching functions in Fig. 2 is not recovered in our data. These differences in the matching functions are independent of the way in which the stimulus is measured (MAF or MAP), and any masking effect owing to 'physiological' noise introduced by applying the stimuli through earphones would have the opposite effect. Thus, the only explanation of the differences in matching functions seems to be that in our study, as opposed to the studies compiled by Lochner and Burger, no fixed comparison stimulus was employed. By employing a fixed comparison stimulus of 1000 cps, the loudness balances involving a variable tone of a very low frequency become quite difficult, and the possibility exists that the S under this condition may become likely to confuse the 'loudness' dimension with other psychological dimensions, such as 'volume' and 'density'. In the present study, each tone was compared to tones with a frequency separation up to, but not greater than, 6/5 of a decade, thus, presumably, greatly reducing the possibility of a confusion with respect to the psychological dimension to be employed.

Theoretical loudness functions and matching functions

Currently, three different expressions for the relationship between stimulating sound intensity and corresponding loudness are being advanced. While all of these expressions are based on a power function relationship, they differ with respect to additive constants introduced to account for the departure from log-log linearity at low intensity levels found for both the loudness and the matching functions. These expressions are as follows:

(1) $$L = K\,(P^2 - P_T^2)^\theta$$

(2) $$L + L_T = KP^{2\theta} \qquad \text{or} \qquad L = K\,(P^{2\theta} - P_T^{2\theta})$$

(3) $$L = K\,[(P^2 + kP_T^2)^\theta - kP_T^{2\theta}],$$

where L is the loudness corresponding to the sound pressure P, P_T is the threshold pressure, and K, k, and θ are constants. It will be seen that (1) (proposed by Scharf & Stevens, 1959) creates a departure from log-log linearity by displacing the effective zero-point of the stimulus dimension, and that (2) (proposed by Lochner & Burger, 1961) accomplishes this effect by displacing the effective zero-point of the loudness dimension. In a formal sense, (3) (developed by Zwislocki as described in Part I) is a combination of (1) and (2).

Denoting by indices x and y two frequencies, and assuming that θ is independent of frequency, (1) and (2) lead to the following two expressions for the matching function between the two frequencies:

(4) $$P_x^2 = \sqrt[\theta]{K_y/K_x}\;P_y^2 + P_{Tx}^2 - \sqrt[\theta]{K_y/K_x}\;P_{Ty}^2$$

(5) $$P_x^{2\theta} = \frac{K_y}{K_x}P_y^{2\theta} + P_{Tx}^{2\theta} - \frac{K_y}{K_x}P_{Ty}^{2\theta}.$$

The expression for the matching function derived from (3) is given in equation (15), Part I.

A comparison between the three possible kinds of theoretical matching functions is given in Fig. 3. The matching data of S LL were used as a basis, and the constants in the different expressions for the matching functions

Insert Fig. 3 about here

were estimated from the asymptotic values of these data. It will appear that, in general, the matching data are better approximated by Zwislocki's expression for the matching function than by any of the other two expressions. Further, it should be noted that only Zwislocki's expression gives a matching function with a double inflection, and that this double inflection is recovered in the matching data for all Ss at all frequencies sufficiently removed from the reference frequency to permit this effect to become apparent (see Figs. 23 - 25, Part II).

(A further argument in favor of the matching function advanced by Zwislocki can be derived from a study by Hellman and Zwislocki (1964). These authors obtained loudness balances between a 1000 cps tone with noise, and a 1000 cps tone without noise. A matching function calculated according to equation (15), Part I, with $\theta = .27$, $k_x = 89$, and $k_y = 2.5$, shows excellent agreement with the data.)

In evaluating the most suitable form of the theoretical function relating 'sensation magnitude' (e.g., 'loudness') to stimulus magnitude, and the matching function derived herefrom, it should be borne in mind that while expressions (1) and (2) are non-specific, expression (3) was developed with special reference to psycho-acoustics. Thus, there is no *a priori* reason to expect that expression (3) will be valid for other sensory modalities.

Acoustic impedance at eardrum

The average acoustic impedance at the eardrum for low levels of the stimulating tone (Fig. 10, Part II) for Ss LL and FP shows good agreement with previous determinations for groups of Ss, as summarized by Zwislocki (1962), and by Feldman and Zwislocki (1965). The possible explanations of the significantly higher values of both resistance and reactance in the case of S JR have already been discussed (Part II).

Although many studies have been concerned with the acoustic impedance at the eardrum as a function of the acoustic reflex (e.g., Dallos, 1964; Feldman & Zwislocki, 1965; Jepsen, 1955; Metz, 1951; Møller, 1962), no data directly comparable to our determinations of acoustic impedance as a function of the intensity of the (ipsilaterally) stimulating tone seem to be available. Feldman and Zwislocki (1965) summarize some of the previous research in terms of the difference in the resistive and the reactive component of the impedance, respectively, associated with relaxed and (presumably) fully activated reflex. A comparison between these values and the maximum changes in the two impedance components of the present data shows much smaller changes for Ss LL and FP, and considerably greater changes for S JR, (although the relative changes for this S are of the same order of magnitude as those summarized by Feldman and Zwislocki). The smaller changes found for Ss LL and FP may be accounted for by reference to the fact that in the present investigation prolonged exposure to the stimulating tone was employed, thus permitting adaptation effects to operate freely.

The pronounced decrease in both impedance components with increasing stimulating intensity found in the present investigation for all frequencies and all Ss apparently has never been reported before. This seems to be due to the fact that this decrease appears only at sound pressure levels in excess of 110-120 db, and that no previous study appears to have employed stimulating sound intensities above this level.

Apparently, sufficient data from previous research are not all available to test effectively the contention (stated in Part III) that the acoustic reflex threshold coincides with an equal-loudness contour. The same lack of pertinent data is encountered regarding the contention (likewise stated in Part III) that the threshold for a decrease in impedance coincides with a contour of equal displacement amplitude of stapes.

Analog approximations of static and of changing acoustic impedance

By adjusting the values of the parameters of Zwislocki's middle-ear analog network, a reasonable approximation between observed acoustic impedances at the eardrum for low levels of the stimulating tone and the input impedance of the analog network was obtained for each S. The corresponding transfer function of the analog network was calculated for each set of adjusted parameter values, and it was shown - assuming this transfer function to be applicable to the ear in question - that the (hypothetical) maximum displacement amplitude of the cochlear partition is approximately independent of frequency for frequencies above 200 cps under the condition of equal-loudness, at sufficiently high loudness levels. This conclusion seems to be in agreement with Zwislocki (1965).

An unsuccessful attempt was made at adjusting the parameter values of the analog network so as to make this network display changes in input impedance similar to the observed changes in acoustic impedance presumably owing to activation of the acoustic reflex for S JR. Similarly, it was not possible to obtain a satisfactory simulation of the observed changes in acoustic impedance presumably associated with a change in the axis of rotation of the malleo-incudal complex for S LL. By extending the analog network developed by Zwislocki to duplicate the effect of a change in the above-mentioned axis of rotation, however, a satisfactory simulation of change of acoustic impedance for this latter S was achieved by assuming that an increase in the compliance of the eardrum precedes or accompanies a change in axis of rotation. No pertinent data from previous studies seem available for an evaluation of this possibility.

Problems for further investigation

In the light of the research presented in this report, two main areas seem in need of further investigation. One area concerns the mechanism responsible for the decrease in acoustic impedance at the eardrum observed at high stimulating sound intensities. In particular, it would be of interest to know if this mechanism is unilateral or bilateral; only in the former case may this drop in impedance be associated with a 'passively' activated change of axis of rotation of the malleo-incudal complex. A further step towards a better understanding of this mechanism would consist of arriving at a closer specification of the effective stimulus for this kind of impedance change. This point could be investigated by measuring the acoustic impedance at the eardrum on Ss with varying kinds of deafness, again as a function of the (ipsilaterally) stimulating tone. Finally, the partial mechanism suggested by the analog analysis of the data of S LL, viz., that the handle of the malleus moves outward at high sound intensities, could be tested either by direct visual observation, or by observing possible changes of volume in front of the eardrum by means of a manometer.

The second main area of interest for further investigation concerns the nature of the acoustic reflex. Although the mechanical action of this reflex is supposedly rather well established, its integration with the remaining middle-ear system apparently is more complex than suggested by Zwislocki's analog network. In addition to this need for a closer specification of the mechanical action of the acoustic reflex, it would be of considerable interest to be able to specify its effective stimulus more exactly, specifically whether 'loudness' is the effective stimulus. One approach to this latter problem would be to apply stimulating tones of varying frequency and intensity to one ear, and measure the acoustic impedance at a given frequency at the opposite ear.

From these data, 'equal-impedance-producing' contours could be constructed for the stimulated ear, and these contours could then be compared with the equal-loudness contours for the same ear. If the two sets of contours follow each other closely, for normal-hearing Ss as well as for Ss suffering from various forms of deafness, 'loudness' may indeed be regarded as the effective stimulus for the activation of the acoustic reflex. (A special case of this comparison would involve the threshold curve for the reflex, and some equal-loudness contour).

Erratum

Last term of equation (15), Part I, to read:

$$+ k_y^{\theta}$$

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Figure Captions

Fig. 1. Continuous curves: Average threshold curve (minimum audible field), and one average equal-loudness contour, compiled from previous research by Lochner and Burger (1962). Points: Average thresholds (minimum audible pressure), and one set of loudness matches, for each of the three Ss of the present study.

Fig. 2. Matching functions relative to 320 cps, reconstructed from the equal-loudness contours compiled by Lochner and Burger (1962).

Fig. 3. Average loudness matches of S LL, and three sets of possible theoretical matching functions. The parameters of these matching functions were estimated from the asymptotic values of the loudness matches for each frequency.

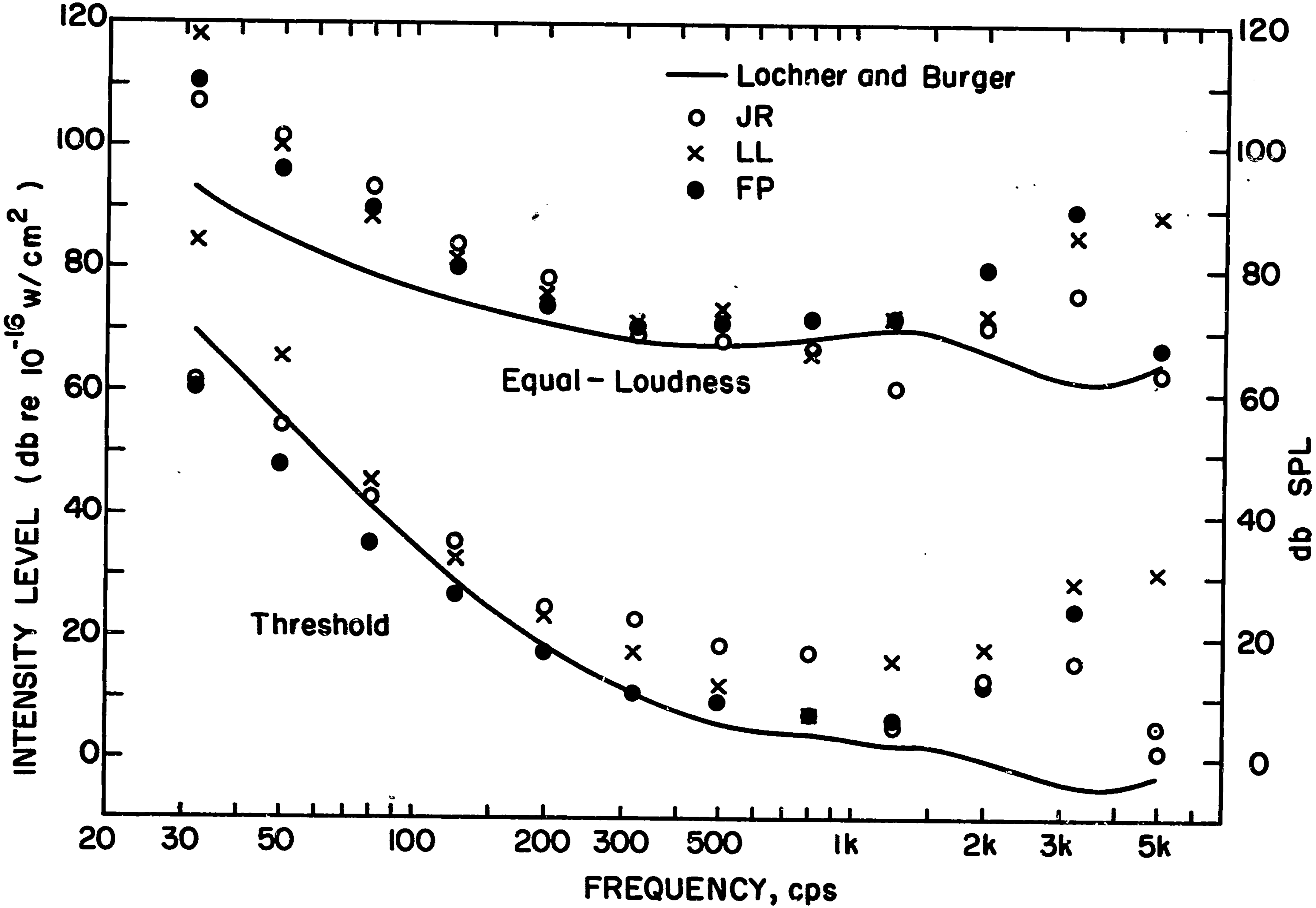

Lochner and Burger
JR
LL
FP
Equal - Loudness
Threshold
INTENSITY LEVEL (db re 10^{-16} w/cm^2)
db SPL
FREQUENCY, cps
120
100
80
60
40
20
0
20
30
50
100
200
300
500
1k
2k
3k
5k

Fig. 1

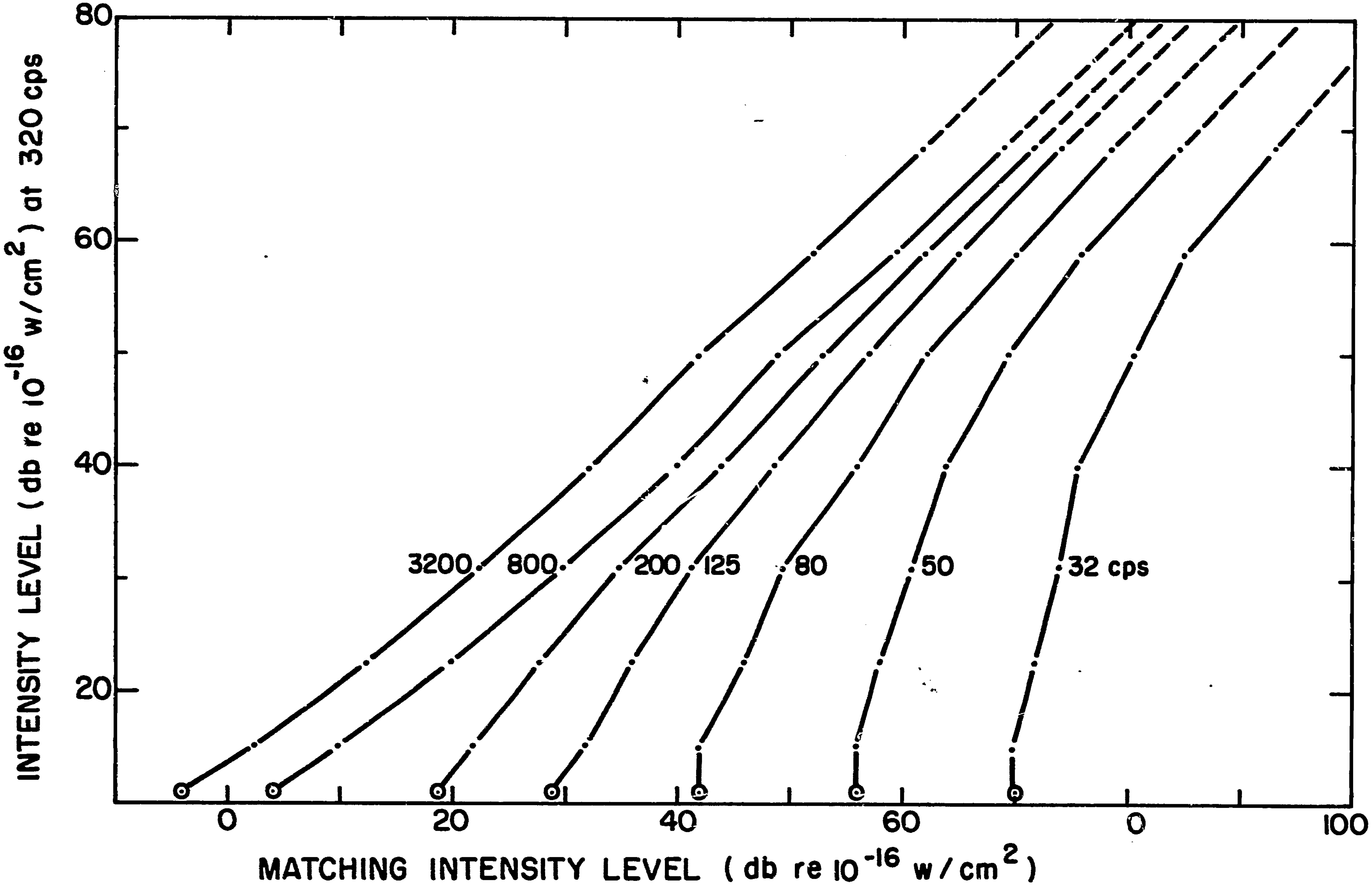
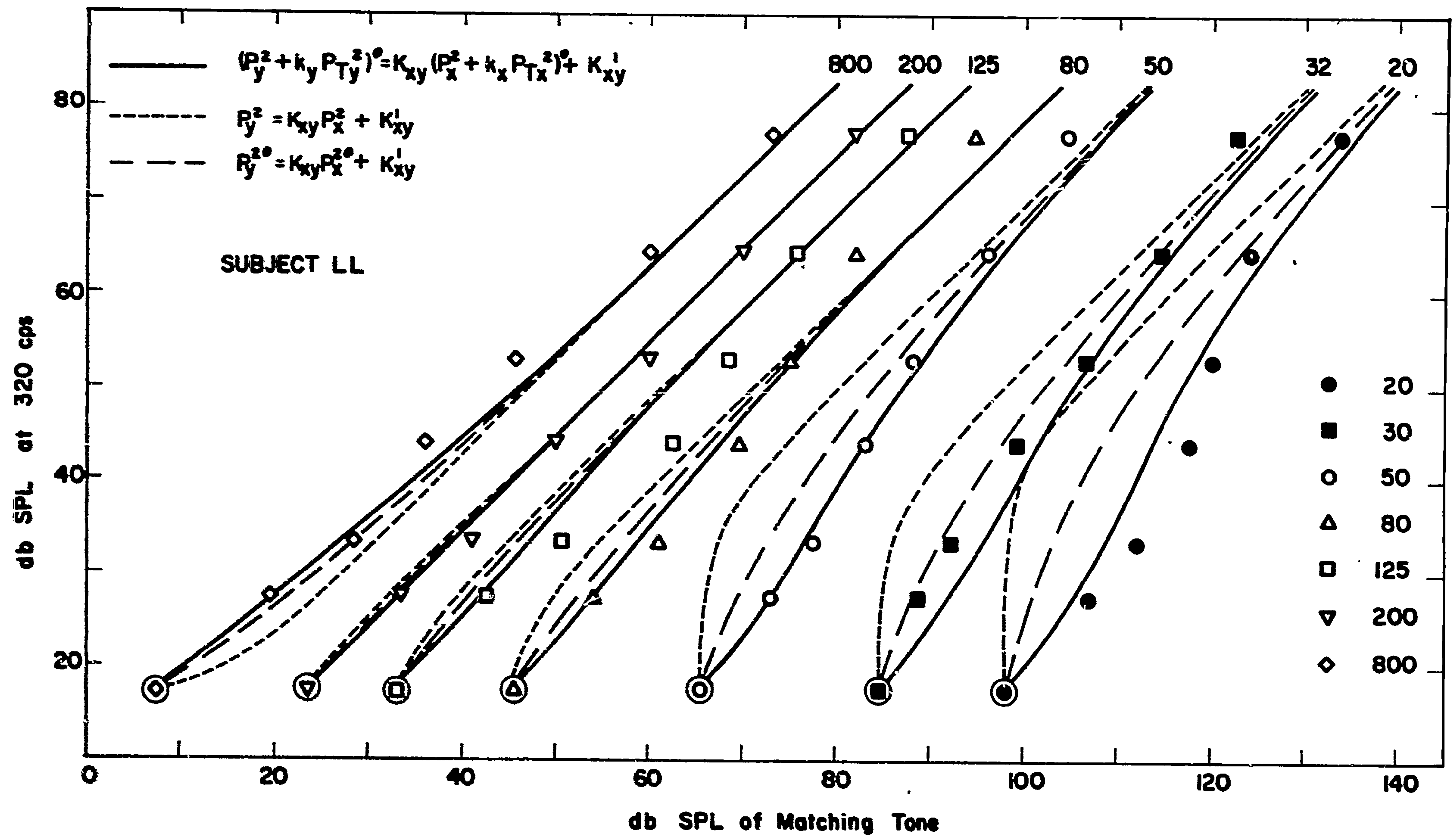

80
60
40
20
INTENSITY LEVEL (db re 10^{-16} w/cm^2) at 320 cps
3200
800
200
125
80
50
32 cps
0
20
40
60
0
100
MATCHING INTENSITY LEVEL (db re 10^{-16} w/cm^2)

Fig. 2



$(P_y^2 + k_y P_{Ty}^2)^\theta = K_{xy}(P_x^2 + k_x P_{Tx}^2)^\theta + K'_{xy}$
$P_y^2 = K_{xy} P_x^2 + K'_{xy}$
$P_y^{2\theta} = K_{xy} P_x^{2\theta} + K'_{xy}$
SUBJECT LL
800
200
125
80
50
32
20
20
30
50
80
125
200
800
db SPL at 320 cps
db SPL of Matching Tone
0
20
40
60
80
100
120
140

Fig. 3

Development of the Prosodic Features of Infant Vocalizing: II

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Abstract

A method is described for analyzing the prosodic features of infant vocalizing. The definition of an utterance is explored by varying the temporal threshold over a range of values from 100 msec to 400 msec. Most of the parameters were found to be unaffected by changes in the temporal threshold within this range. Results for the 100 msec temporal threshold are presented. There are few developmental trends. Significant exceptions are the average fundamental frequency and average duration both of which show a similar trend. Three hypotheses are advanced to account for the observed trends. Correlations between the parameters are presented and discussed.

A preliminary report on the development of prosodic features of infant vocalizing has appeared previously (Sheppard & Lane, 1966). The method employed began with complete and continuous recordings of all the vocalization of two infants during the first five months of life. These recordings started with the birth cries and continued uninterrupted as the infants were moved to private rooms at the hospital and then into plexiglass "air-cribs" at home. The recordings were sampled for analysis by selecting three 95-sec samples of vocalizing at specified times during the day, every fourth day, for the first 141 days of life. The prosodic features of vocalizing were analyzed by extracting three acoustic parameters-fundamental frequency (cps), amplitude (decibels), and duration (msec) during each of the 108 samples. The outputs of the parameter extractors (analog electronic devices) were measured every 25 msec by an analog-to-digital converter, then processed by an on-line digital computer. Composite statistics, describing the three prosodic features of the vocalizing in each sample, were then computed.

Two modifications of the previously described method have been made. The preliminary results reported were based on a temporal threshold ($\underline{t}_o$) of four out of five samples. During subsequent data analysis $\underline{t}_o$ was varied over a wide range of values. The 100 msec (4 samples) temporal threshold used in the present report was arrived at as a result of these studies (described below). These studies also revealed that the frequency distribution of duration was highly right-skewed, whereas the frequency distributions of fundamental frequency and amplitude were not. Accordingly, the statistics presented here are based on the linear values of these parameters, rather than on their logarithmic transformations, as in the earlier report, with the exception of duration for which both arithmetic and geometric means are reported.

Results and Discussion

Defining an utterance

Three parameters of the technique of prosodic analysis determine the definition of an utterance in this study and, hence, the magnitude of various response statistics. These are the amplitude, frequency, and temporal thresholds. The appropriate values of the first two are reasonably specified by considerations discussed in the earlier report, but the most suitable setting of the temporal threshold ($\underline{t}_o$) seemed more equivocal and was explored. Four values of the temporal threshold were studied: four out of five samples, 100 msec (four samples), 200 msec (eight samples) and 400 msec (sixteen samples). This range of $\underline{t}_o$ values was established with reference to both physiological and statistical considerations. Neuromuscular constraints on the respiratory and vocal apparatus probably set a lower bound to inter-response times in the region of 100 msec. (Rothenberg, 1966).[1] On the other hand, when utterances separated by more than 400 msec are pooled, the measures of within utterance variance in the parameters are greatly inflated. Tables 1 and 2 show the effects on several measures of

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Insert Tables 1 and 2 about here

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infant vocalizing of varying this parameter of the analysis. A comparison of the data obtained using the 400 msec $\underline{t}_o$ and 100 msec $\underline{t}_o$ shows that the statistics for most of the parameters are relatively unaffected by the choice of the $\underline{t}_o$ within this range. (The results for the four out of five samples $\underline{t}_o$ were almost identical with those for the 100 msec $\underline{t}_o$; the results for the 200 msec $\underline{t}_o$ were intermediate between those for the 400 msec $\underline{t}_o$ and the 100 msec $\underline{t}_o$.) The first exception is the higher arithmetic mean duration of utterances, $M_a(D)$, for the 400 msec $\underline{t}_o$ than for the 100 msec $\underline{t}_o$. The second exception is the higher measures of within utterance variability in fundamental frequency, M(CVF), and amplitude, M(CVA), for the 400 msec $\underline{t}_o$ than for the 100 msec $\underline{t}_o$. Since most of the statistics reported are remarkably stable over a wide range of $\underline{t}_o$, and since an increase in $\underline{t}_o$ only increases the duration and within utterance variability of utterances, both of which indicate that two or more distinct vocal responses are being compounded into one utterance, 100 msec was chosen as the temporal threshold.

Trends in prosodic features

Table 2 presents several statistics that describe the prosodic features of infant vocalizing, averaged over blocks of nine samples and also over all samples. Statistics reported for the distribution of the mean fundamental frequencies of utterances are its central tendency, M(MF), skewness, G(MF), and variance expressed as the coefficient of variation between utterances, CV(MF) = S(MF)/M(MF). Also shown is the average coefficient of variation within utterances in the fundamental frequency measures, M(CVF) = M(SF/MF), and the skewness of the associated distribution, G(CVF); the average coefficient of variation within utterances in the amplitude measures, M(CVA) = M(SA/Ma), and the skewness of the associated distribution, G(CVA). For the frequency distribution of utterance durations, Table 2 shows the central tendency, M_a(D), the skewness, G(D), and the variance expressed as the coefficient of variation, CV(D) = S(D)/M(D); the geometric mean, M_g(D), is also given, since the distribution turns out to be highly right-skewed. Product-moment correlations are reported among the following statistics, as shown in Table 2: utterance duration (D), mean utterance fundamental frequency (MF), mean utterance amplitude (MA), within utterance variability in fundamental frequency (SF), and within utterance variability in amplitude (SA).

All of the statistics reported in Table 2 (except measures of skewness and most of the correlations) are plotted in Fig. 1 as a function of age and sample number, averaged over blocks of nine samples. Inspection of the developmental changes in the fundamental frequencies of utterances over the first 141 days shows that the M(MF) at birth was approximately 438 cps; then it decreased to 411 cps by sample number 18 (approximately 21 days), and

Insert Fig. 1 about here

remained there until sample number 36 (approximately 45 days); and then it rose and stabilized at about 450 cps for the duration of the study. The average skewness for the associated distributions, $\overline{G(MF)}$, reported in Table 2 is .482, indicating that the distributions are slightly positively skewed. The coefficient of variation between utterances in fundamental frequency, CV(MF), remained nearly constant (.096-.136) over the entire study. That is to say, the infant's utterances did not become more (or less) variable in pitch as he grew older: approximately two-thirds of the utterances in a typical sample had fundamental frequencies within about ten percent of the mean value. The average coefficient of variation within utterances in fundamental frequency, M(CVF), remained similarly constant (.086-.113); the associated distributions are not appreciably skewed, $\overline{G(CVF)}$ = .305. We may conclude that the infant's pitch did not fluctuate during an utterance more (or less) as he grew older: approximately two-thirds of the readings of his fundamental frequency during a typical utterance were within ten per cent of the mean pitch of that utterance.

The average coefficient of variation within utterances in amplitude, M(CVA), also remained nearly constant (.291-.382); the associated distributions are not skewed $\overline{G(CVA)}$ = .035. The $\overline{M(CVA)}$, reported in Table 2 is .349; this is considerably higher than the $\overline{M(CVF)}$, .098, showing that the variability in amplitude within utterances is greater than the variability in fundamental frequency within utterances.

The arithmetic mean duration of utterances, $M_a(D)$, was approximately 613 msec at birth; then it decreased to 466 msec by sample number 18 (approximately 21 days) and remained there until sample number 36 (approximately 45 days); and then rose to the region of 600 msec for the rest of the study. The average skewness for the frequency distributions of utterance durations, $\overline{G(D)}$, reported in Table 2, is 1.33, indicating that the distributions are highly positive skewed. Thus, there were, in addition to many responses of short duration, a number of long ones, although, as can be seen from Table 2, this spread was reduced somewhat with increasing age. Indeed, some of the distributions showed slight bimodality; however, it proved impossible to find a non-arbitrary value of one or a number of parameters in combination that would sort the responses into two (or more) classes. The coefficient of variation between utterances in duration, CV(D), decreased from 1.23 to .909 over the study indicating that the average duration of utterances within a sample became more uniform as a function of age. The geometric mean duration of utterances, $M_g(D)$, was approximately 267 msec at birth, then it decreased to 229 msec by sample number 18 (approximately 21 days) and remained there until sample number 36 (approximately 45 days), and then rose and stabilized at about 300 msec for the duration of the study.[2] The trend of the geometric mean duration is the same as that for the arithmetic mean duration but the magnitude of the former is smaller, since the frequency distributions of the utterance durations are highly positive skewed.

Possible sources of developmental trends

Several of the statistics presented in Fig. 1 show a similar developmental trend. Noteworthy is the covariation of average fundamental frequency, M(MF), and average duration, $M_a(D)$ and $M_g(D)$. The parameters show a decrease from their initial values by sample number 18 (approximately 21 days), then an increase to a value that exceeds their initial level, and finally stability for the duration of the study.

Three possible explanations of these developmental trends suggest themselves. First, the observed trend in the measures could be the result of chance fluctuations. This explanation seems rather unlikely in view of the consistency of the trend across different measures, and the magnitude of the fluctuations.

A second possible explanation is based on considerations of the infants' physiological development. Increases in the area, thickness, and length of the vocal cords with age, would lead (other things equal) to a decrease in fundamental frequency which could account for the initial drop in the value of this parameter. However, an increase with age in the subglottal pressure that the infant can develop (owing to neuromuscular and anatomical development of the respiratory mechanism) would contribute to an increase in fundamental frequency. The successive occurrence of these two antagonistic developments could produce the observed trends.

A third possible explanation involves the greater fundamental frequency and duration of crying responses than those of non-crying responses. The initial high level of these measures is due in this interpretation to the relative frequency of unconditioned-reflex crying-responses; the values of these measures then decrease as the relative frequency of unconditioned-reflex crying decreases with age (Lenneberg, 1965). Later, a new class of operant crying-responses appears. These responses occur more often as they come to be controlled by environmental events. Thus, there is something of a time-lag between the gradual disappearance of reflexive crying and the gradual appearance of motivated crying.

Of course, both behavioral and physiological changes may enter into the final account of the development trends observed, if they prove replicable.

Correlations among parameters

Figure 1 shows that the correlation between the average amplitude of utterances, MA, and the average fundamental frequency of utterances, MF, decreased from .357 to .141 over the study. To speculate a little further, this decrease may reflect a change in the mode by which the infant produces variations in fundamental frequency. An infant at birth presumably lacks control of the musculature involved in the mass and tension of the vocal cords; therefore, the primary manner in which variations in fundamental frequency occur is by corresponding variations in subglottal pressure. The latter would also be correlated with changes in the sound pressure generated. Hence, this mode of voicing control yields a high correlation between MF and MA.

As the child matures and gains control of the laryngeal musculature, changes in fundamental frequency can be produced by neuromuscular, as well as aerodynamic, mechanisms.[3] This would result in a lower correlation between average fundamental frequency and average amplitude since changes in fundamental frequency can then occur largely independent of amplitude.

The overall correlations reported in Table 2 between (MF,MA), (MF,SA) and (MF,D) are less than .25; between (MF,SF), (MA,SF), (SF,SA) and (SF,D) they are .25 or greater but less than .50; and between (MA,SA), (MA,D) and (SA,D) they are greater than .50. All of the correlations involving the mean utterance fundamental frequency, MF, show only a slight relationship (less than .25), except r(MF,SF). The correlations between the standard deviation within utterances in fundamental frequencies, SF, and all four other variables are moderately high (between .25 and .50). The correlations between the mean utterance amplitude, MA, the standard deviation within utterances in amplitude, SA, and the duration of utterances, D, are greater than .50 . It is particularly interesting to note that longer utterances typically have greater amplitude and shorter, less.

Replication

At present, tape recordings made under comparable conditions with a second infant are undergoing similar analysis, in order to examine how replicable are the magnitudes and trends of parameter values obtained in this study.

Footnotes

1. Rach (1960) has shown that the delay between the appearance of a proprioceptive impulse during the execution of an arbitrary movement and the motor correction elicited was about 100 msec. This coincides with estimates by various authors of minimal syllable duration (Kozhevnikov & Chistovich, 1965).

2. Ringwall, Reese, and Markel (1965) report that 81. per cent of the utterances in four minute segments of vocalizing obtained from 40 three-day-old infants were judged by trained listeners to be shorter than the word "pit" as it is normally pronounced. Measurement of the word "pit" produced by several different speakers shows its duration to be approximately 350 msec. Thus, this measure of the duration of infant utterances agrees with the present findings.

3. "The fundamental frequency of phonation is thus a function of the subglottal air pressure function and it falls during the last 150-200 msec of phonation [of a sentence]... the falling terminal fundamental frequency contour... is a universal aspect of the unmarked breath-group. Data on the cries of newborn infants show that... the fundamental frequency falls at the end of phonation because the subglottal pressure falls... Developmental data indicates that children apparently acquire the idiosyncratic [laryngeally-controlled] aspects of the breath-group of their native language during the first year of life." (Lieberman, 1966, p.4.)

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Figure Caption

Fig. 1. Developmental trends in the prosodic features of an infant's vocalizing. Each statistic is presented as a function of age and sample number, averaged over blocks of nine samples.

Table 1

Statistics describing the prosodic features of infant vocalizing for $\underline{t}_o$ of 400 msec, averaged over blocks of nine samples and also over all samples (Σ).

Blocks of Nine Samples

	1	2	3	4	5	6	7	8	9	10	11	12	Σ
M(MF)	486	409	405	407	442	476	450	478	446	450	450	455	446
G(MF)	.253	-.323	.081	.410	.260	.433	.789	.549	.568	.790	.332	.054	.350
CV(MF)	.096	.095	.090	.112	.090	.101	.088	.098	.093	.114	.088	.079	.095
M(CVF)	.111	.097	.114	.110	.099	.125	.109	.129	.104	.124	.123	.101	.112
G(CVF)	-.001	-.232	.057	.015	.309	-.235	.062	.034	-.029	.118	.014	.118	.019
M(CVA)	.372	.351	.373	.337	.446	.435	.447	.439	.430	.445	.454	.438	.414
G(CVA)	.376	.103	-.111	.202	-.189	-.124	-.364	-.276	-.139	-.273	-.202	-.298	-.108
M_a(D)	1195	784	809	546	847	899	1012	1621	1142	879	1027	1222	999
G(D)	1.66	1.62	1.93	1.83	1.44	1.44	.975	1.14	.961	.908	1.06	1.09	1.34
CV(D)	1.15	1.12	1.08	1.17	.982	.936	.923	.902	.820	.773	.780	.771	.951
M_g(D)	495	341	398	266	457	481	508	770	543	539	635	719	513
r(MF,MA)	.272	.379	.392	.149	.240	.050	.079	-.013	.304	.221	.281	.178	.211
r(MF,SF)	.438	.447	.523	.481	.451	.561	.556	.500	.559	.586	.566	.330	.500
r(MF,SA)	.324	.460	.430	.177	.265	.074	.112	.072	.291	.253	.288	.208	.246
r(MF,D)	.235	.326	.383	.252	.178	.129	.126	.123	.213	.197	.169	.162	.208
r(MA,SF)	.217	.410	.275	.194	.293	.222	.245	.246	.327	.246	.215	.188	.257
r(MA,SA)	.831	.803	.787	.809	.894	.901	.897	.884	.900	.913	.900	.908	.869
r(MA,D)	.559	.613	.571	.545	.487	.541	.505	.489	.578	.530	.485	.540	.537
r(SF,SA)	.362	.517	.384	.287	.367	.272	.326	.363	.391	.307	.249	.265	.341
r(SF,D)	.263	.363	.278	.368	.382	.371	.395	.440	.406	.334	.254	.259	.343
r(SA,D)	.523	.611	.476	.548	.501	.592	.528	.543	.662	.565	.507	.599	.555

Table 2

Statistics describing the prosodic features of infant vocalizing for $\underline{t}_o$ of 100 msec, averaged over blocks of nine samples and also over all samples (Σ).

Blocks of Nine Samples

	1	2	3	4	5	6	7	8	9	10	11	12	Σ
M(MF)	438	411	404	408	442	477	454	481	447	451	452	456	443
G(MF)	.495	.007	.316	.462	.189	.478	.747	.781	.846	.713	.579	.175	.482
CV(MF)	.126	.121	.122	.130	.112	.122	.124	.119	.106	.136	.120	.096	.120
M(CVF)	.096	.088	.102	.099	.086	.104	.102	.113	.092	.107	.104	.086	.098
G(CVF)	.269	.108	.161	.242	.446	.183	.332	.277	.419	.308	.363	.546	.305
M(CVA)	.316	.293	.309	.291	.382	.362	.380	.380	.363	.364	.376	.367	.349
G(CVA)	.502	.186	.117	.336	-.062	.003	-.205	-.093	-.125	-.091	-.004	-.145	.035
M_a(D)	613	466	477	327	518	502	604	729	548	565	629	623	550
G(D)	1.71	1.51	1.62	1.77	1.39	1.63	1.15	1.26	.744	1.08	1.12	1.02	1.33
CV(D)	1.23	1.10	1.08	1.08	.964	.988	1.01	.934	.815	.901	.940	.909	.996
M_g(D)	267	229	250	179	286	284	294	385	322	314	330	342	290
r(MF,MA)	.357	.219	.225	.101	.204	-.013	-.057	.030	.199	.169	.132	.130	.141
r(MF,SF)	.540	.483	.536	.458	.359	.446	.436	.409	.442	.514	.422	.303	.446
r(MF,SA)	.433	.383	.335	.183	.218	.008	.003	.067	.203	.179	.145	.153	.193
r(MF,D)	.062	.242	.304	.236	.135	.037	.047	.033	.149	.131	.073	.094	.133
r(MA,SF)	.278	.304	.188	.173	.305	.216	.207	.195	.292	.305	.284	.253	[illegible]
r(MA,SA)	.845	.752	.761	.776	.901	.902	.905	.861	.909	.923	.919	.921	.865
r(MA,D)	.488	.614	.625	.573	.564	.577	.626	.472	.597	.592	.586	.678	.583
r(SF,SA)	.432	.446	.321	.281	.359	.274	.282	.311	.359	.351	.312	.312	.337
r(SF,D)	.105	.273	.243	.328	.418	.388	.360	.341	.366	.351	.309	.296	.315
r(SA,D)	.410	.639	.539	.559	.535	.597	.609	.492	.647	.626	.585	.677	.576

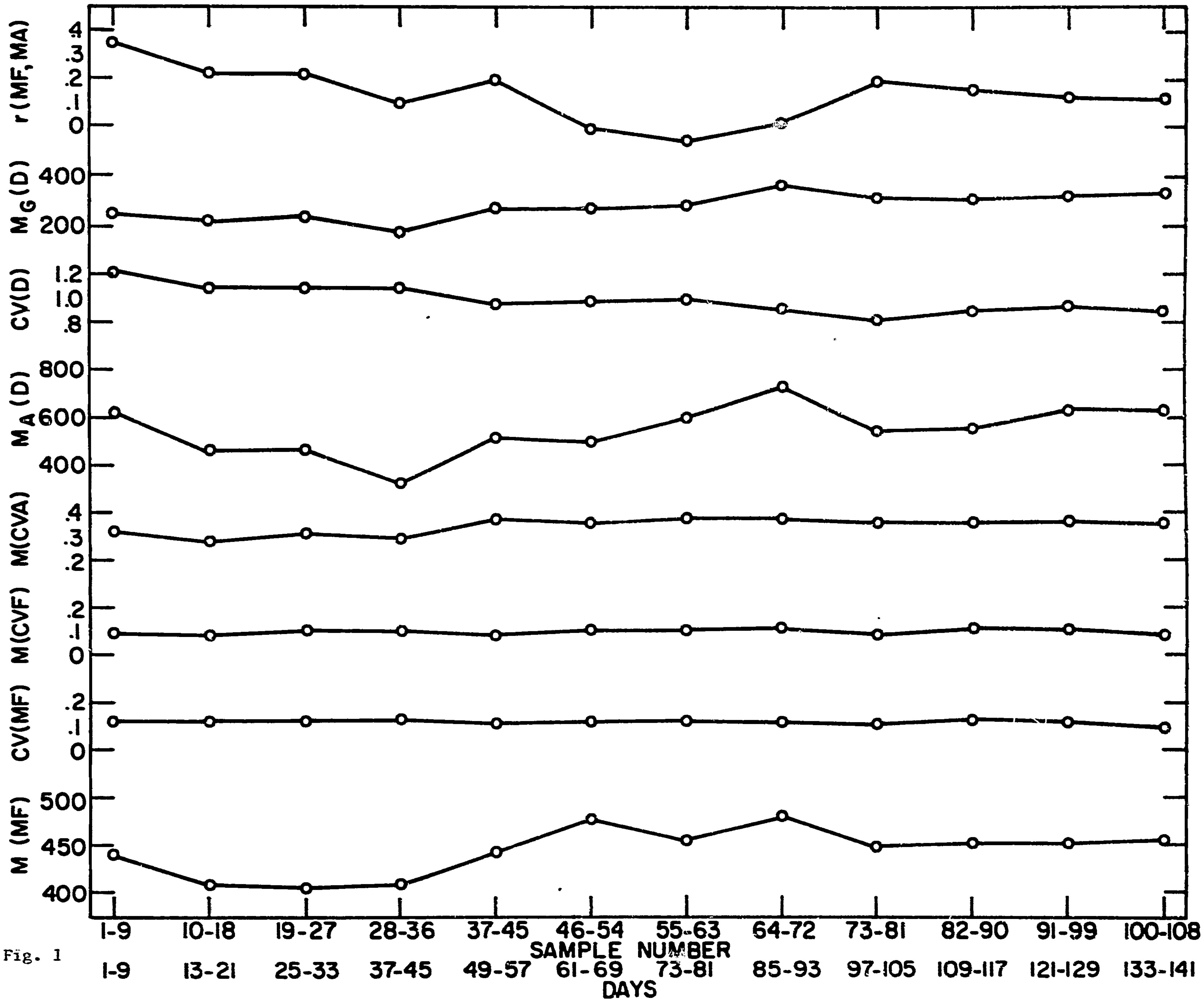
r (MF, MA)
.4
.3
.2
.1
0
M_G(D)
400
200
CV(D)
1.2
1.0
.8
M_A(D)
800
600
400
M(CVA)
.4
.3
.2
M(CVF)
.2
.1
0
CV(MF)
.2
.1
0
M (MF)
500
450
400
1-9
10-18
19-27
28-36
37-45
46-54
55-63
64-72
73-81
82-90
91-99
100-108
SAMPLE NUMBER
1-9
13-21
25-33
37-45
49-57
61-69
73-81
85-93
97-105
109-117
121-129
133-141
DAYS

Fig. 1

An Analysis of the Differences in the Prosodies of General American English and Colloquial Jordanian Arabic and Their Effect on Second-Language Acquisition

by

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Abstract

This study is concerned with an instrumental contrastive analysis of the prosody of General American English (GAE) and Colloquial Jordanian Arabic (CJA). The main purpose of this study, the first specifically contrastive linguistic analysis of the prosodic features of GAE and CJA, is to identify the areas of difficulty involved in the teaching of prosodic features of GAE to native speakers of CJA.

A distinctive feature of this research is the use of the Speech Auto-Instructional Device (SAID) for analyzing and teaching prosodic features of both the native and target languages. The effectiveness of the SAID system as an electro-mechanical device was tested in these matters.

Recordings of English informants and Jordanian subjects (Ss) speaking English provided the corpus for the study. Fifty-four utterances were selected from this corpus for analysis. For comparison, the CJA translation of these utterances were also recorded. Based on electro-acoustic analysis by the SAID system and the judgments of linguistically-trained listeners, the utterances were rated with respect to their prosodic accuracy in GAE.

The results revealed characteristic errors made by Jordanian Ss. These errors were first classified into three categories (stress, rhythm and intonation). The differences between the prosodic patterns of the two languages were then described and interpreted.

The study produced the following conclusions: 1) The Jordanian Ss incorrectly pronounced some GAE words of more than one syllable. For example, in disyllabic compound words, they placed primary stress on the second syllable and secondary stress on the first syllable, influenced by their language stress habits, as in "rȍommáte." 2) The Jordanian Ss pronounced the words of GAE utterances clearly and loudly, giving each word its citation value in terms of length and stress. 3) The Jordanian Ss had special difficulty with GAE intonation patterns falling to pitch /4/, as well as with some rising-falling and falling-rising intonations. For example, they substituted the CJA falling

intonation "2-3 for the GAE falling intonation "2-4, which made their speech sound incomplete and unfinished to native speakers of English. 4) It has been determined that CJA has three degrees of lexical stress which are nonphonemic, since they can be predicted according to the consonant-vowel structure of the word. The stresses have been labeled: primary [´], secondary [`] and weak [˘]. In addition CJA has two more kinds of stress: contextual stress and sentence stress, both of which are phonemic. 5) Three relative pitch-levels have been found in the CJA intonation system. These pitches have been referred to as pitch level /1/, the highest pitch of CJA; pitch level /2/, and pitch level /3/, the lowest pitch in CJA used by speakers for normal conversation. 6) CJA rhythm is found to be "word-stressed timed," though its effect is something like syllable-timing. This is due to the fact that a CJA utterance has a very high frequency of primary and secondary stresses. 7) The analysis revealed two contrastive pauses in CJA: (a) final pause marking the completion of an utterance, and signaled primarily by a lower than usual fall to pitch /3/; (b) non-final pause signaling tentativeness or incompleteness. Before a non-final pause of a falling contour the pitch does not drop as low as it would before final pause and may even include a slight rise in pitch. 8) Learning through SAID is time-consuming and expensive. However, with further improvement it could prove to be one of the most effective means of teaching prosodic features of a second language efficiently, especially in situations where the number of students is small, or where native teachers of the target language are scarce.

CHAPTER ONE

INTRODUCTION

1.1 Aim

In recent years, quite a few materials and dissertations concerned with the phonology, morphology, and syntax of Arabic have been written. However, there are very few works dealing wholly or even partly with the prosodic features of the language.[1] The only major modern work (that I know of) devoted wholly to this subject is that of George Abdalla.[2] With the exception of this work, there is no modern linguistic treatment of the prosodic features of either colloquial or classical Arabic.

No satisfactory contrastive studies of the prosody of American English and Arabic dialects have been done, either, certainly none from a pedagogical viewpoint. There are two works that deal partly with the contrastive analysis of the prosody of the two languages: Kennedy's[3] and Nasr's,[4] both of which offer only limited details. Therefore, it is apparent that the present study is badly needed for both linguistic and teaching purposes, since it is mainly concerned with an instrumental analysis of the prosodies of General American English (GAE) and Colloquial Jordanian Arabic (CJA).

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[1] Sobleman, H. (Ed.) Arabic dialect studies, a selected bibliography, Wash., D.C.: Center for Applied Linguistics, Modern Language Association, 1962.

[2] Abdalla, A. G. "An instrumental study of the intonation of Egyptian colloquial Arabic." Unpublished doctoral dissertation, Univ. of Michigan, 1960.

[3] Kennedy, N. M. Problems of Americans in mastering the pronunciation of Egyptian Arabic. Wash., D.C.: Center for Applied Linguistics, Modern Language Association, 1960.

[4] Nasr, R. T. "The phonological problems involved in the teaching of American English to native speakers of Lebanese Arabic." Unpublished doctoral dissertation, Univ. of Michigan, 1955.

The main purpose of the research reported here is not to give a full description of the prosody of CJA, but to identify the areas of difficulty involved in the teaching of prosodic features of GAE to native speakers of CJA. However, a contrastive analysis of these aspects of the two languages and a delineation of the areas of interference between them require an initial description of the prosody of CJA, restricted to the corpus of data. Perhaps this work will facilitate further research in the field by predicting problems that are involved in the teaching of prosodic features of Arabic to native speakers of English.

A distinctive feature of this research is the use of the Speech Auto-Instructional Device (SAID) for analyzing and teaching the prosodic features of both the native and target languages.[5]

1.2 Method

Informants and Subjects

The corpus was recorded and developed with the cooperation of two groups: English informants and Jordanian subjects (Ss). The first group consisted of John C. Catford[6] and Alton L. Becker.[7] Becker was selected as the speaker of GAE. The second group was selected from four Jordanian students, three of whom had recently arrived in the United States. The latter

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[5]For more details and a technical account of the operation of the SAID system see: Buiten, R. L., and Lane, H. L. "A self-instructional device for conditioning accurate prosody." IRAL, 3, 205-219, 1965.

[6]Professor of Linguistics, Director of the English Language Institute, Univ. of Michigan and Member of Executive Committee, Center for Research on Language and Language Behavior.

[7]Instructor in English and Linguistics and Research Assistant, Center for Research on Language and Language Behavior.

group consisted of:

Habib Fakhoury from the city of Salt.

Hazar Hijazi from the city of Irbid.

Abdallah Nusur from the city of Salt.

Basim Shihadah from the city of Irbid.

The members of this group represent the educated class in Jordan; have lived in towns all their lives; and have received their elementary and secondary education in Jordanian governmental schools. The Ss' home towns are adjoining communities and their dialects are homogeneous. Hence, the speech habits of the Ss constitute one of the two major CJA dialects--the dialect of the Eastern bank of Jordan. Although these Ss studied English for eight years in Jordan and spent five to eight months studying in the United States before the start of this project, their knowledge of English was not good enough to enable them to use the language correctly and efficiently in their speech and writing.

Procedure

The corpus collected for recording consists of five English dialogues, especially prepared for the study of intonation, stress and rhythm. These dialogues contain fifty-four utterances selected for analysis. The following criteria were used to select these utterances:

1. They include items of everyday and personal nature that have a high degree of usefulness to Jordanian students learning English.
2. They include examples of affirmative and negative statements, yes-no questions, wh- questions, attached questions, greetings, requests, and commands as well as exclamatory sentences.
3. They include items that vary in length, grammatical construction, and phonetic structure.

4. They include items that have the same lexical meaning but have a variety of intonations which allow for the comparison and contrast of various degrees of pitch and stress.

The English informants and the Jordanian Ss were requested to produce the normal speech of daily conversation while recording on magnetic tape, and to act out the dialogues in a natural way. For comparative analysis the CJA translation-equivalents of the fifty-four English utterances mentioned above were recorded by the Ss.

Analysis of the Corpus

The recorded tapes were played back and the fifty-four utterances selected for analysis were picked out of the recorded dialogues for each informant and S and copied on another set of tapes. This new set of tapes had the selected utterances for all the informants and Ss arranged according to their occurrence in the dialogues. This created the need for making a third set of tapes on which the utterances were arranged in the following order: (1) the category of greetings with its various intonation patterns, (2) the category of statements, (3) the category of yes-no questions, (4) the category of wh- questions, (5) the category of requests and commands, (6) the category of exclamatory sentences, and (7), the category of attached questions.[8] Finally, a new set of tapes was prepared so that a listener could first hear a model recording as performed by the English informant, and then the recording of the same utterance by one of the Ss. This was done with each pair of utterances.

Later, incorrect productions of the prosodic features of GAE by Ss were sorted out. First, I listened to the tapes, taking each pair of utterances as they were copied on the final set of listening tapes. The performance of

[8] The order in which these categories are presented will be accounted for in Chapter 4, p. 62.

the model(M) was compared with that of the S for amplitude, pitch and tempo. If the two utterances appeared to have different stress, rhythm, or intonation patterns, they were marked to be singled out. Otherwise, they were left unmarked. The resultant list was then classified into three major categories pertaining to stress, rhythm and intonation.

Following this, a listening experiment was run in which five native English speakers and two non-native English speakers, all linguistically trained, participated. They are:

Peter Abboud, Assistant Professor of Linguistics, University of Texas

John Applegate, Associate Professor of Linguistics, UCLA

Alton Becker, Instructor of English and Linguistics, University of Michigan

John Catford, Professor of Linguistics, University of Michigan

Daisy Crystal, Instructor of English, Columbia University

Carolyn Killean, Ph.D. candidate in Linguistics, University of Michigan

Ernest McCarus, Associate Professor of Near Eastern Languages and Literatures, University of Michigan

The listeners were first given a sheet of instructions that explained what was involved in the experiment. They were asked to listen to the tapes of English utterances by Jordanians, and to mark the primary stress points and intonation contours. This marking was done on an attached form[9] which included all the utterances arranged in order. A final consensus of the listeners' reaction was then made for each S and later on for all Ss.[10]

Finally, using the SAID system (pitch and intensity analyzer and pen-writer),[11] strip charts of the selected utterances were completed for analysis

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[9] See Appendix II-C, pp. 172-173.

[10] See Appendix II-D, E, F, G, H, pp. 174-194.

[11] See Buiten and Lane, op. cit.

as they were copied on the final tapes. The charts were very helpful in showing variations in amplitude, pitch, and tempo between the performancesof the English informants and the Ss. This provided an evaluation of the SAID system as an electro mechanical device for analyzing the prosody of foreign languages.[12]

In addition to SAID analysis and the listening experiment, spectrograms for some of the utterances selected for analysis were made. These spectrograms were useful in checking on the strip charts and in delimiting relevant information with regard to some intonation contours. In conjunction with the study of CJA rhythm, it was found necessary to produce mingograms[13] for a few CJA translation-equivalents of the English utterances in order to determine if CJA rhythm is syllable-timed, word-stressed timed, or phrase-timed.[14] The results obtained from an analysis of the charts were then compared with the results from the listening experiment, as well as with the judgment of the author. Eventually, a final consensus of the three judgments (one machine and two human) was established.[15] This consensus became the foundation upon which prediction and illustration of the areas of difficulty between the two languages were based.

The difficulties pinpointed were then classified into three groups of problems: stress, rhythm, and intonation. Finally, the problems of each category were presented in the following manner: indication of the problem involved, its description, and its interpretation in relation to any difference found in this research between GAE and CJA prosodic patterns.[16]

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[12] See Chapter 5, pp. 101-107.

[13] See Fig. 3, p. 35.

[14] See Fig. 3, p. 35 and Chapter 3, pp. 31-37.

[15] See Appendix II-J,K, pp. 199-206.

[16] For details see Chapter 4, pp. 48-100.

1.3 Transcription

The phonemic transcription used in this research for some of the English utterances is based on that used by Lado and Fries in English Pronunciation.[17] Below is a phonemic representation of the English segmentals as used by the authors.

Vowels

i	/it/	eat
ɪ	/ɪt/	it
e	/let/	late
ɛ	/lɛt/	let
æ	/mæn/	man
ə	/bət/	but
a	/nat/	not
u	/du/	do
ʊ	/gʊd/	good
o	/no/	no
ɔ	/sɔ/	saw

Dipthongs

aɪ	/aɪ/	I
aʊ	/naʊ/	now
ɔɪ	/bɔɪ/	boy

---

[17] English Language Institute staff (Robert Lado and Charles C. Fries) English Pronunciation. Ann Arbor: University of Michigan Press, 1958. p. viii.

Consonants

b	/bi/	be
d	/du/	do
f	/fɔr/	four
g	/go/	go
h	/hom/	home
k	/kəm/	come
l	/let/	late
m	/mæn/	man
n	/no/	no
p	/pe/	pay
r	/rum/	room
s	/se/	say
t	/taɪm/	time
v	/vaʊəl/	vowel
w	/wi/	we
y	/yu/	you
z	/zɪro/	zero
ŋ	/sɪŋ/	sing
θ	/θɪŋk/	think
ð	/ðe/	they
š	/ši/	she
ž	/yužʊəl/	usual
č	/čərč/	church
ǰ	/ǰo/	Joe

Arabic phonemic transcription

Following is a list of the CJA phonemic symbols, illustrated by examples taken from my data were possible.

Phonemic Symbol	Phonemic Transcription	English Equivalent
Vowels		
aa	/saami/	'sami'
uu	/ʔaxuu/	'I take'
oo	/hoon/	'here'
ii	/kiif/	'how?'
ee	/ʔeeš/	'what!'
a	/bas/	'but'
u	/gul/	'say' (imperative)
i	/mumkin/	'may'
Consonants		
b	/baḥibb/	'I like'
t	/tuukil/	'you eat'
θ	/θamaanya/	'eight'
j	/ʔijjaay/	'next'
ḥ	/ḥaalak/	'your condition'
x	/ʔaxuu/	'his brother'
d	/dagiiga/	'minute'
ð	/ʔaaxuð/	'I take'
r	/raayiḥ/	'will you'
z	/zurt/	'I visited'
s	/sana/	'year'
š	/šaay/	'tea'
č	*/čilma/[18]	'word'

[18] Words carrying asterisk are not taken from data.

Consonants

ṣ	/ṣaḥiiḥ/	'is it true?'
ṭ	/ḥaṭhum/	'he put them'
ð̣[19]	/ð̣aabiṭ/	'officer'
ʔ	/ʔisim/	'name'
ʕ	/ʕarabi/	'Arabic'
ɣ	/luɣa/	'language'
f	/fariid/	'Farid'
g[20]	/gult/	'you said'
k	/kiif/	'how?'
l	/ḥaalak/	'your condition'
ḷ	/ʔaḷḷa/	'God'
m	/mliiḥa/	'comfortable, good'
n	/ʔanaa/	'I'
h	/hoon/	'here'
w	/ween/	'where?'
y	/ya /	'O' (vocative)

---

[19] One <u>S</u> replaced ð̣ with ḍ according to literary Arabic tradition.

[20] One <u>S</u> replaced /g/ with /q/ because of residence in a /q/ area.

1.5 Symbols and Abbreviations

The following symbols and abbreviations are used:

V:	Short vowel
VV:	Long vowel
C:	Consonant
M:	Model
S:	Subject
Ss:	Subjects
GAE:	General American English
CJA:	Colloquial Jordanian Arabic
SAID:	Speech Auto-Instructional Device
/ :	Designates tentative (non-final) pause
// :	Designates final pause
/ / :	Encloses phonemic symbols
[ ] :	Encloses phonetic symbols
...+...+...:	Denotes boundary of rhythm unit
~ :	Denotes omission of word-initial /ʔ/ and no break in phonation. Always placed after the vowel regardless of original morpheme boundaries.

Pitches:

/1/ :	Extra high
/2/ :	High
/3/ :	Mid
/4/ :	Low
↗ :	Indicates slight rise without change in pitch level.

2-4: An intonation contour which starts at pitch level /2/ and ends at pitch level /4/.

"2-4: An intonation contour under primary stress.

'2-4: An intonation contour under secondary stress.

3-"2-4: Precontour of pitch level /3/ preceding the intonation contour "2-4.

"2-4-: An intonation contour, the ending point of which does not change pitch but continues on the same level of pitch /4/.

Stresses

´ : Primary stress

` : Secondary stress

˘ : Weak stress

" : Sentence stress

CHAPTER TWO

BRIEF DESCRIPTION OF THE PROSODY OF GAE

This chapter includes a brief description of the prosody of GAE. My analysis represents a composite analysis based on those done by Pike,[1] Lado,[2] Sledd,[3] Hill,[4] Stockwell and Bowen,[5] and Trager and Smith.[6] The criterion for inclusion of any item was its relevance to the contrastive study that forms the body of this research.

2.1 Stress

In the description of patterns of stress in GAE, linguists use two systems: the four-stress system and the three-stress system. Followers of the first recognize four phonemic degrees of stress that are determined according to their position in words. Trager and Smith[7] and Hill[8] call these stresses: primary /´/, secondary /`/, tertiary /^/, and weak /˘/. Sledd calls them: strongest /´/, second /^/, third /`/, and weakest /˘/.[9] On the other hand, linguists who support the second system recognize only three

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[1] Pike, Kenneth L. *The Intonation of American English*. Ann Arbor: University of Michigan Press, 1956. Chapters 3 and 4.

[2] Lado, Robert. *Linguistics Across Cultures*. Ann Arbor: University of Michigan Press, 1957. Chapter 2.

[3] Sledd, James. *A Short Introduction to English Grammar*. Chicago: Scott, Foresman and Co., 1959. Chapter 1.

[4] Hill, Archibald A. *Introduction to Linguistic Structures*. New York: Harcourt, Brace and Co., 1958. Chapter 2.

[5] Stockwell, Robert P., and Bowen, J. D. *The Sounds of English and Speech*. Chicago: University of Chicago Press, 1965. Chapter 3.

[6] Trager, George and Smith, Henry. *An Outline of English Structure*. Norman, Oklahoma: Battenburg Press, 1951. pp. 35-52.

[7] Trager, G. and Smith, H. *loc. cit.*, p. 37.

[8] Hill, A. A. *loc. cit.*, pp. 14-21.

[9] Sledd, J. *loc. cit.*, pp. 32-33.

significant degrees of word stress. Stockwell and Bowen give the following names: strong / ´ /, medial / ` /, and weak / • /.[10] And Lado labels them: primary / ´ /, secondary / ` /, and weak / • /.[11]

These degrees of word stress are all phonemic, since they contrast with each other in minimal pairs of nouns and verbs.[12]

Examples:

pérmit vs. permít

óbject vs. objéct

In the GAE utterance, primary word stress can be shifted associated with an intonation contour according to the speaker's intention. This type of stress is described in terms of sentences and is used for emphasis; it is traditionally called sentence stress.[13,14] Following are some examples for illustration:

How do yőu like living in America?

How do you like li̋ving in Ámerica?

For the convenience of comparative analysis with CJA word stress patterns and for the facilitation of the learning of these stress patterns by Jordanian students, I would like to use a three-stress system and call the three degrees of word stress: primary / ´ /, secondary / ` /, and weak / ˘ /. However, on the sentence level the foregoing three lexical stresses will be used plus one louder, which is called sentence stress / " /.

The distribution of word stress patterns in GAE takes various forms: some disyllabic words, for example, have primary stress on the first syllable and weak stress on the second.

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10 Stockwell and Bowen op. cit., p. 21

11 Lado, R. op. cit., pp. 28-29.

12 Sledd, J. op. cit., p. 31.

13 Lado, R. op. cit., pp. 28-31.

14 Pike, K. op. cit., p. 84.

Examples:

Énglĭsh

lánguăge

mórnĭng

In another pattern, disyllabic words take weak stress on the first syllable and primary stress on the second one.

Examples:

bĕlíeve

ĕxám

ăbóut

A third common pattern, including words consisting of three syllables each, takes primary stress on the middle syllable and weak stresses on the rest, as in the following:

ĕlévĕn

sĕméstĕr

ănóthĕr

The usual stress pattern of compound words in GAE is primary stress followed by secondary stress:

máilmàn

roómmàte

There is a group of monosyllabic words of frequent use which receive strong stress when produced in isolation or when put under special emphasis in an utterance. These words normally receive weak stress when they occur in connected conversations. Here are some examples:

am, is, are

has, have, had

you, your, his, them

to, of, for

Vowel reduction is a widespread phenomenon in GAE. This reduction has such an influence on the syllables involved that in some cases, where strong stress is replaced by weak stress, some of their vowel phonemes completely disappear. Observe the following:[15]

Does he understand?

/də́z hí əndərstǽ̋nd/

/də̀z hî əndərstǽ̋n/

/dəzɪəndərstǽ̋n/

/dəzɪ ənərstǽ̋n/

Another significant feature is that syllables receiving primary stress are generally pronounced longer than the others, especially under the influence of sentence stress. Observe the pronunciation of the word <u>he</u> in the following pair of utterances:

Doe̋sn't he?
(Expecting confirmation)

/də̋znt hɪ/

Doesn't he̋?
(Asking for information)

/də̀znt hí̋/

This is in agreement with the findings of Trager and Smith[16] and Lado,[17] namely that in GAE one of the factors deciding the length of a syllable is the degree of stress given to it.

GAE stress habits allow the replacement of secondary stress with primary stress in sentences indicating contrastive situations:

Ȅnglish is a dífficult language to learn. (English not Arabic)

Ènglish is a di̋fficult language to learn. (Difficult not easy)

---

[15]This example as well as the list of monosyllabic words given in the preceding paragraph are illustrative only. For a full discussion of English vowel reduction, see "A Guide to Pronunciation," <u>Webster's Third New International Dictionary of the English Language</u>. Springfield, Massachusetts: G. & C. Merriam 1966. Pp. 33a - 46a.

[16]Trager, G. and Smith, H. <u>op</u>. <u>cit</u>., pp. 39-40.

[17]Lado, R. <u>op</u>. <u>cit</u>., p. 32.

It is important to add that in contrastive situations or when special emphasis is required, choice of the placement of sentence stress is determined by what item in the sentence is to be emphasized. The following examples are given for illustration:

How do "you like living in America?

How do you "like living in America?

2.2 Pause

In GAE, there are two types of pause:[18]

1. Tentative pause: It often occurs in sentence medial position but it may occur any other place "where the attitude of the speaker includes uncertainty or nonfinality ...."[19] This type of pause is short in duration; it is symbolized by a single bar / . Note the following:

   a. Fahd had lived a comfortable life, but his brother hadn't.
   "1-3- -3 / 3- "2-3 -4//

   b. May I have another cup of tea, please.
   3- "3-2- /"3-3 //

2. Final pause: This type occurs in sentence final position, signaling finality. It lasts longer in its duration than the former type, and is symbolized by a double bar // . Here are some examples:

   a. English is a difficult language to learn.
   3- "2-4 //

   b. He's been studying English for eleven years.
   3- "2-4- -4//

---

[18] The description that follows is based on Pike's <u>The Intonation of American English</u>, pp. 31-33.

[19] Pike, K. L. <u>Ibid</u>, p. 32.

2.3 Rhythm

In GAE, as analyzed by Pike, Fries, et al., and Lado, syllables tend to be pronounced in groups, producing what they call "simple rhythm groups."[20,21] In general, each such simple rhythm group includes only one stress, sometimes preceded or followed by unstressed syllables. Here are some words, taken from the data, as examples:

Fáhd

Yésterday

Seméster

It is worthy of mention that in GAE, the stress and intonation of rhythm groups made up of phrases are similar to rhythm groups made up of isolated words. Hence, the tempo involved in pronouncing a phrase that constitutes a rhythm group is more or less the same as that for pronouncing a word that constitutes a simple rhythm group. Note the following:

eight + miles

It's eight + miles.

It's about eight + miles.

It's about twenty-eight + miles.

Furthermore, Fries and Lado claim that a combination of phrases constituting rhythm groups produces a sentence rhythm that is composed of a series of separate waves of about the same length. This near

[20] For further details see: Pike, K. L. op. cit., pp. 34-40.

[21] Lado, Robert and Fries, Charles op. cit., pp. 60-62.

uniformity gives each rhythm group approximately the same time-duration that is given to other rhythm groups included in an utterance, no matter whether the latter contain more or less syllables. According to this view, GAE rhythm leads to the reduction of the number of syllables in long rhythm groups and the prolongation of syllables in short ones, in order to even up the time element. That is why GAE is characterized by a "phrase stress-timed" rhythm. This is illustrated in the examples given below:

English is a + difficult + language to + learn.

Where did you + put your regis+tration ma+terials?

2.4 Relative Pitch Levels

Pike lists four significant relative pitch levels, which he considers the "basic building blocks for intonation contours and their meanings."[22] These levels of pitch are fixed by their height relative to one another. Pike believes them to be at equal intervals in relation to each other.[23]

1. extra-high, labeled number /1/, used to indicate greater attention than any other level.
2. high, labeled number /2/, used for special attention but not as great as the pitch labeled number /1/.
3. mid, labeled number /3/, used as a kind of base line for normal conversation.
4. low, labeled number /4/, the lowest pitch used by speakers.

The following examples show the four pitch levels in contrast:

1. What's his brother's name?
3- "2-4/
(Normal question)

2. What's his brother's name?
3- "1-4-3/
(Repeated with surprised attention)

---

[22]Pike, K. L. <u>op</u>. <u>cit</u>., p. 26.

[23]<u>Ibid</u>.

3. What's his brother's name?
   3-   "2-1/
   (Echo question)

2.5 Primary Intonation Contours as Included in My Data[24]

1. Falling contours

   a. <u>Primary contour "1-4</u>:

   This primary contour occurs once in my data, in pause group final position. It follows pitch level /3/, precontour. It implies contrastive pointing like "2-4, but the contrast here is more intense, added by pitch level /1/.

   Example:

   English is a difficult language to learn.
   3-   "1-4   -4//

   b. <u>Primary contour "1-3</u>:

   This contour occurs non-finally in pause group position. Sometimes, it is preceded by precontour of pitch level /3/. It gives the meaning of contrastive pointing plus non-finality.

   Fahd had lived a comfortable life, but his brother hadn't.
   "1-3-   -3 /   "2-3-   -4//

   c. <u>Primary contour "2-4</u>:

   This is the most frequent primary contour in GAE. It occurs in pause group final position; it occurs in statements, questions, commands, and greetings; it covers a syllable, a word, a phrase and sometimes extends over the whole utterance. It is often preceded by precontours of pitch level /3/. This contour indicates contrastive pointing and finality.

---

[24]See Tables 1 and 4, pp. 25, 47.

Examples:

1. English is a difficult language to learn.
   3- "2-4//

2. How are you?
   3- "2-4/

3. What's his brother's name?
   3- "2-4/

4. Doesn't he?
   "2- -4/.
   (Confirmatory attached question)

d. <u>Primary contour "2-3</u>:

This contour occurs in pause group final position followed by a drop to pitch /4/ at the end of the utterance. It signals contrastive pointing and finality added by pitch /4/. Examples of this primary contour are:

1. English is a difficult language to learn.
   "2-3- -4//

2. Will you be here next semester?
   3- "2-3- -4/

2. Rising contours

a. <u>Primary contour "2-1</u>:

There is one example of this primary contour in my data. It occurs in pause group final position, with precontour of pitch level /3/. It signals an echo question, giving the meaning of unexpectedness. Here is an example:

What's his brother's name?
3- "2-1/

b. <u>Primary contour "3-1</u>:

This contour occurs in pause group final position, without a precontour. It indicates unexpectedness, surprise, and incompleteness. There is only one example:

```
 What, Mahdi!  I can't believe that.
"4-2 / "3-1   /   "2-4           -4//
```

c. Primary contour "3-2:

This contour has no restrictions in its occurrence. It occurs non-finally and finally, preceded by precontours of pitch level /3/; sometimes it has no precontours preceding. It expresses incompleteness, sequence, and unexpectedness. Under primary stress, it implies contrastive pointing. When it occurs in pause group final position, it often signals a question that requires an answer. Below are some examples:

```
1.  Where did you say he put them?
   "3-2-                        -2/.

2.  May I have another cup of tea, please.
    3-          "3-2          -3/  "3- -3//

3.  Will you be here next semester?
    3-                     "-3-2 /
```

d. Primary contour "4-2:

There are two occurrences of this type in my data: first in final pause group position with no precontours preceding, and second, covering the whole utterance. In the former case, it signals incomplete deliberation plus incomplete sequence and surprise, and in the latter one, it signals a question tag asking for information. For example:

```
1. What!  Mahdi!  I can't believe that!
  "4-2 / "4-  1/  3-"2-4-          -4//

2. Doesn't he?
  "4-      -2/
```

e. Primary contour "4-3:

This contour occurs only once, in non-final pause group position and without precontours. Like the preceding primary contour "4-2, it gives the meaning of incomplete deliberation plus unexpectedness--but in a milder manner.

```
What, Madhi!  I can't believe that!
"4-3 / "3-1  /  3-"2-4-          -3//

What Mahdi!   I can't believe that!
"4-3 "3  -1/  3-"2-4-           -3//
```

3. Level contours

Primary contour "3-3:

This primary contour occurs in final position. It implies coherence and unification, as in the following example:

```
May I have another cup of tea, please.
3-         "3-2                / "3-3//
```

4. Falling-rising primary contours

a. Primary contour "1-4-3:

I have only one example of this primary contour. It occurs in final position, marking the end of a question, with no precontours preceding. It signals incomplete deliberation plus unexpectedness or surprise.

```
What's his brother's name?
3-                    "1-4-3/
```

b. Primary contour "2-4-3:

This contour occurs non-finally, without precontours. It involves incomplete deliberation plus contrastive attention. For example:

```
Do you really like to eat Arab food?
3-          "2-4-3-          -4/

English is a difficult language to learn.
3-
                                   "2-4-3//
```

c. Primary contour "2-3-2:

This contour occurs once in pause group final position, with no precontours. It implies a related meaning of implication.

Wait a minute.
"2-3-2 -4//

5. Rising-falling contours

a. Primary contour "3-2-4:

There is only one occurrence of this contour, in pause group final position. It has no precontours preceding. Here it signals unexpectedness plus contrast.

What! Mahdi! I can't believe that!
"4-2 /"4-1 / 3- "3-2-4//

b. Primary contour "3-2-3:

This primary contour occurs finally, without precontours. It involves incompleteness, contrastive pointing and perhaps unexpectedness. My data include only one example:

Do you really like to eat Arab food?
3- "3-2-3- -4/

c. Primary contour "2-1-4:

This contour occurs finally following a precontour of pitch level /3/. It implies politeness and cheerfulness especially in greetings.

Good morning, William.
3- "2-1-4- -4//

TABLE 1

Summary of GAE Primary Contours
Included in the Corpus of Data

Type	Number	Type	Number	Type	Number	Type	Number	Type	Number
1. <u>Falling</u>		2. <u>Rising</u>		3. <u>Level</u>		4. <u>Falling-rising</u>		5. <u>Rising-falling</u>	
1-4	1	4-1	1	3-3	2	1-4-3	1	3-2-4	2
2-4	35	4-2	3			2-4-3	2	2-1-4	1
1-3	1	4-3	1			2-3-2	1		
2-3	5	3-1	1						
		3-2	5						
		2-1	1						
Sub-total	42		12		2		4		3
Total	63								

CHAPTER THREE

DESCRIPTION OF THE PROSODY OF CJA, RESTRICTED TO THE CORPUS

This chapter includes a restricted description of the prosody of CJA. This is my own analysis based on three sources: The final consensus obtained from the listening experiment especially prepared for this purpose,[1] the judgment of the SAID system, and the judgment of the author as a native speaker of CJA.

The preparation of this description plus the one in the previous chapter will enable me to deal conveniently with the contrastive analysis of the prosody of the two languages under study, with the purpose of locating and describing the major problems that native speakers of CJA meet when they try to learn the prosody of GAE.

Stress

In CJA words, it is possible to identify three phonetic degrees of stress: primary [ˊ], secondary [ˋ] and weak [˘]. These lexical stresses are always determined by the structure of the word. The rules for the placement of lexical stress are as follows:

1. The first occurrence of VCC or VV from the end of the word receives primary stress.

   a. In words including only one occurrence of VCC or VV, other vowels before or after the occurrence receiving primary stress take weak stress.

   Examples:

[băṣáddĭg]	'I believe'
[mádrăsă]	'School'
[ṣăbáaḥ]	'Morning'

   b. In words including more than one occurrence of VCC or VV, the first occurrence from the end of the word receives primary stress, and the second receives secondary stress. Other vowels in the word receive weak stress.

Examples:

[nitʕallámhă] 'We learn it'

[kùbbáayĭt] 'Cup'

[ʕàazmíinhŭm] 'We are inviting them'

2. Words that do not include the occurrence of VCC or VV take primary stress on the first vowel from the beginning of the word, and weak stress on the rest.

Examples:

[dárăsăt] 'She studied'

[kátăbă] 'He wrote it'

[ʔábădăn] 'Never' (always)

When used in the context of a sentence, CJA lexical stress is usually retained. However, there are cases where primary lexical stress is reduced to secondary and sometimes to weak. Thus, on the utterance level, there are three phonemic contextual stresses: primary /´/, secondary /`/ and weak /˘/. The following examples are given for illustration:

1. ṣaárlu byúdrusi⁓nglíizi ḥdáʕšar sănа.

'He's been studying English for eleven years.'
(Matter-of-fact statement)

2. ʔilinglíizi lùɣa sáʕba nitʕallàmha.

'English is a difficult language to learn.'
(Matter-of-fact statement)

In addition to lexical and contextual stress, CJA has a third type of stress which functions on sentence level. This type is phonemic and is used for contrastive situations and special emphasis. This I will call sentence stress and mark it by the symbol /"/. Sentence stress is louder than the three degrees of contextual stress and may be placed on any word in the CJA utterance. Examples follow:

ṣáarlu byúdrusi~ngl̈iizi~ḥdáʕšar sàna.

'He's been studying Ëꞌnglish for eleven years?'

ṣaárlu byüdrasi~nglíizi~ḥdáʕšar sǎna.

'He's been stüdying English for eleven years?'

Sentence stress and pitch are interrelated, in that the nuclear tone or change-point of an intonation pattern is normally located at the place where sentence stress occurs. However, there is some evidence that sentence stress and pitch are independently variable and both are therefore phonemic. Notice how in the first pair of the following examples, there is a change of pitch but no change of amplitude on the syllable <u>tan</u>; whereas in the second pair the pitch rises on the syllable <u>heek</u> of the second utterance while the amplitude is lessened in relation to the first utterance. This is represented graphically in Figs. 1 and 2.

1. a) ʔiṣtanna dagiiga
   3-"2-3- "3-3 //
   (Normal request)

   'Wait a minute.'

   b) ʔistanna dagiiga
   3-"1-3- "3 -3//
   (Spoken with annoyance)

   'Wait a minute.'

2. a) mišheek?
   "3--2/,
   (Confirmatory attached question)

   'Doesn't he?'

   b) mišheek?
   3-"3--1/,
   (Asking for information)

   'Doesn't he?'

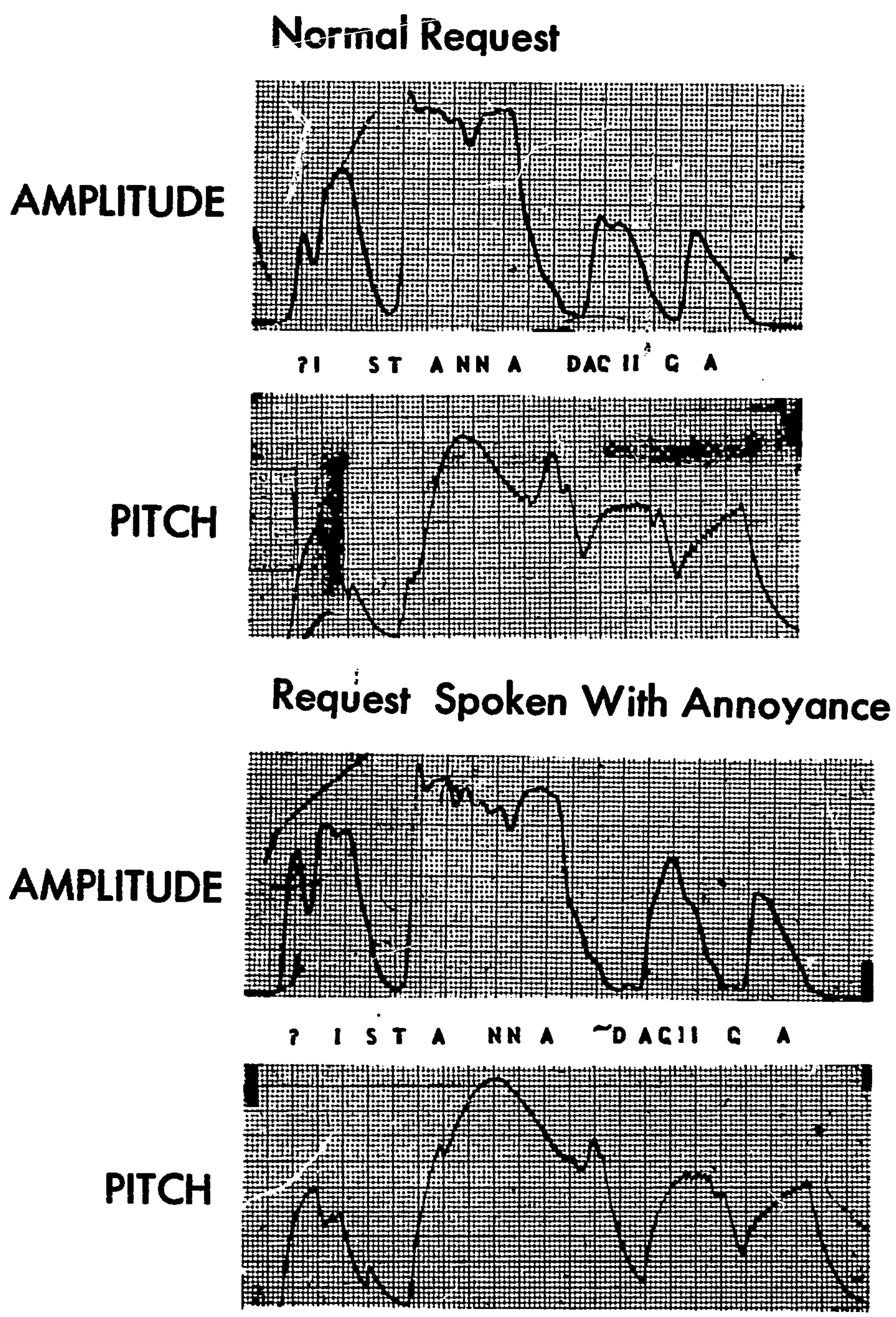

Fig. 1. Graph showing change in pitch in CJA, but without change in sentence stress.

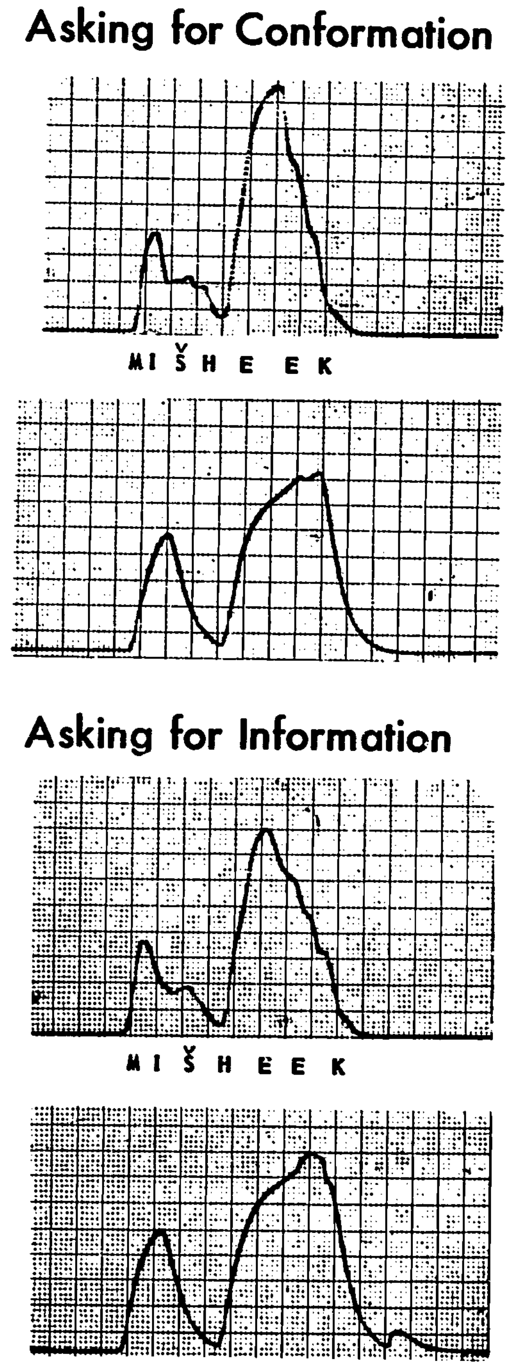

Fig. 2. Graph showing that CJA pitch and sentence stress may be independently variable.

Pause

The CJA equivalents of the selected English utterances reveal two significant contrastive pauses: final designated by double slant lines //, and non-final designated by a slant line /.

Final pause may be of longer duration than non-final, but not necessarily so, and marks the completion of an utterance. It is signaled primarily by a lower than usual fall to pitch level /3/, as in the following example:

```
ʔilingliizi luɣa ṣaʕba nitʕallamha.
3      "2-3-       "2-3-         '2-3- //
```

'English is a difficult language to learn.'
(Matter-of-fact statement)

Non-final pause is usually short in duration, and marks the end of segments of incomplete utterances, signaling tentativeness or incompleteness. These will include, for example, questions as well as interrupted statements. Before a non-final pause of a falling contour, the pitch does not drop as low as it would before final pause, and may even include a slight rise in pitch, though not enough to constitute a change in level. Other features such as vocal quality, tenseness, tempo, etc., which do not concern us here, also distinguish non-final from final pause. Examples of non-final pause follow:

```
1.  fahd ʕaaš ḥayaa mliiḥa, bas ʔaxuu maa ʕaaš.
    3-   "2-2           "3-3 / 3-   "2-3"2-3-  -3//
```

'Fahd had lived a comfortable life, but his brother hadn't.'
(Emphasis on <u>had</u> and <u>hadn't</u>)

```
2.  majabši~lboosṭaji ~lmaktuubi~mbaariḥ?
    3- "2-3-  "2-3-            "2-3-  "3-  -2 /
```

'Didn't the mailman deliver the letter yesterday?'
(Asking with unexpectedness and surprise)

2. sahiiḥ bitḥibb tuukil ʔakil ʕarabi?
3-"2- -2/

'Do you really like to eat Arab food?'

(Is it true?)

3.3 Rhythm[3]

Like GAE, CJA is stress-timed; the time-lapse between major stresses is approximately equal; hence the duration of each stress-group is about the same.[4] There is a fundamental difference here, however, between the two languages. In CJA almost every word in an utterance has a primary or secondary stress, whereas in GAE, many words (so-called "structure words" or "function words", e.g., articles, pronouns, auxiliary verbs, prepositions) are normally weak-stressed in conversational speech. These weak-stressed English words cluster together in GAE with the strong-stressed words (so-called "content" words). These word-clusters are often translation-equivalents of single Arabic words, consisting of a stem plus one or more bound morphemes. Note the translation-equivalents of the underlined parts in the following:

1. What's <u>his bróther's</u> name? (normal question)

   axúu

2. Where did you say <u>he pút them</u>? (inquiring about the place)

   ḥáthum

3. <u>I'm hóping to go báck</u> this year. (matter-of-fact statement)

   batʔámmal árjaʕ

---

[3] The author acknowledges the help of Professor John Catford and Professor Ernest McCarus in analyzing CJA data.

[4] Pike, K. L. <u>Phonemics</u>, The University of Michigan Press, Ann Arbor, pp. 13, 251-252, 1947

It was stated that CJA is stress-timed like GAE, but that in CJA every separate word has either primary or secondary stress. Therefore, it might also be said that CJA is "word-stress timed." Consequently, the CJA subject, speaking GAE, follows the CJA pattern of giving primary or secondary stress to every word. This results in many GAE grammatical words receiving a stress.

It is very important to repeat that CJA rhythm is not syllable-timed, though its effect often is something like syllable-timing. For example:

M: Fahd had lived a + cómfortable + life but his + brother + hadn't.
(Fahd in contrast with his brother)

S: Fahd + had + lived + a com/fortable + life + but + his + brother + hadn't.

If CJA were truly syllable-timed, the word comfortable would be pronounced (com/for/ta/ble). The stress-shift from cómfortable to comfórtable is related to CJA habits of word stress (See CJA stress patterns, pp. 26-27)

That CJA is "word-stress timed" and not "syllable-stress timed" has been also verified by the preliminary results obtained from the "Beat Experiment."[5] The experimental design and apparatus used here were similar to those used in the analogous experiment conducted by George D. Allen for English prose rhythm. The present study used only four utterances heard by three Ss. The four selected utterances are as follows:

[5] This was suggested by Mr. George D. Allen, a doctoral candidate in the Department of Communication Sciences, University of Michigan. Mr. Allen has conducted an analogous experiment for his doctoral research, "Two behavioral measures of syllable beat in conversational English" which is supported by the University of Michigan Center for Research on Language and Language Behavior.

1. baḥibb~aʕarfak ʕazamiili fariid.

   'I'd like you to meet my roommate, Farid.'
   (Farid is my roommate)

2. ṣaarlu byudrusi~ngliizi~ḥdaʕšar sana.

   'He's been studying English for eleven years.'
   (Matter-of-fact statement)

3. ʔilingliizi luɣa ṣaʕba nitʕallamha.

   'English is a difficult language to learn.'
   (Matter-of-fact statement)

4. mumkin ʔaxxuð kubbaayit šaay θaanya law samaḥt.

   'May I have another cup of tea, please.'
   (Asking for another cup of tea)

It is important to mention that the "Beat Experiment" as applied to the study of CJA rhythm is incomplete and, therefore, its results are to be considered preliminary and tentative. More examples, Ss, and other statistical measures are needed in order to obtain the necessary data for a complete study of CJA rhythm. This is beyond the scope of my research and forms a separate study by itself that is open to future research.

The Ss were first given the utterance printed on a sheet of paper and divided into syllables. The first utterance was then replayed for them on a tape loop fifty times.[6] They were instructed to tap to the first syllable of the utterance each time it was repeated. The same procedure was repeated for the second syllable of the utterance, then the third, and so forth to the end of the fourth utterance.

The means of distributions of the taps for each syllable for each S were later computed and then marked by perpendicular lines on

[6] Fifty times seemed to be the optimum number based on Mr. Allen's experiment.

the mingogram[7] prepared for the same utterance under study. Preliminary data based on the distributions of the means for all Ss for two of the selected utterances have indicated whether the syllables tapped to were rhythmic or non-rhythmic. These two utterances are:

1. baḥibb~aʕarfak ʕazamiili fariid.

   'I'd like you to meet my roommate, Farid.'
   (Farid is my roommate)

2. ʔilingliizi luɣa ṣaʕba nitʕallamha.

   'English is a difficult language to learn.'
   (Matter-of-fact statement)

The syllable on which the means of distributions of the taps for the three Ss fall close to one another within the syllable boundaries was considered a rhythmic syllable, whereas other syllables, on which the means of distributions were scattered wide apart from each other and beyond the syllable boundaries, were non-rhythmic. It was easier for the Ss to tap to these rhythmic syllables, while they swiftly passed over non-rhythmic syllables in between major beats. (Figure 3 is given for illustration.)

Analysis of the two utterances selected for careful study of CJA rhythm shows that, although almost every word in the CJA utterance has primary and/or secondary stress(es), there is only one rhythmic syllable (rhythmic syllables have been found to be those syllables under primary stress in the two utterances analyzed). These rhythmic syllables are the major blocks on which rhythm in the CJA utterance depends. This is in agreement with the argument given at the beginning of this section - that CJA rhythm is "word-stress timed." See Tables 2 and 3 for illustration.

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[7] Mingograms for the four utterances were produced at the Communication Sciences Laboratory, University of Michigan. Figure 3 is given as an example.

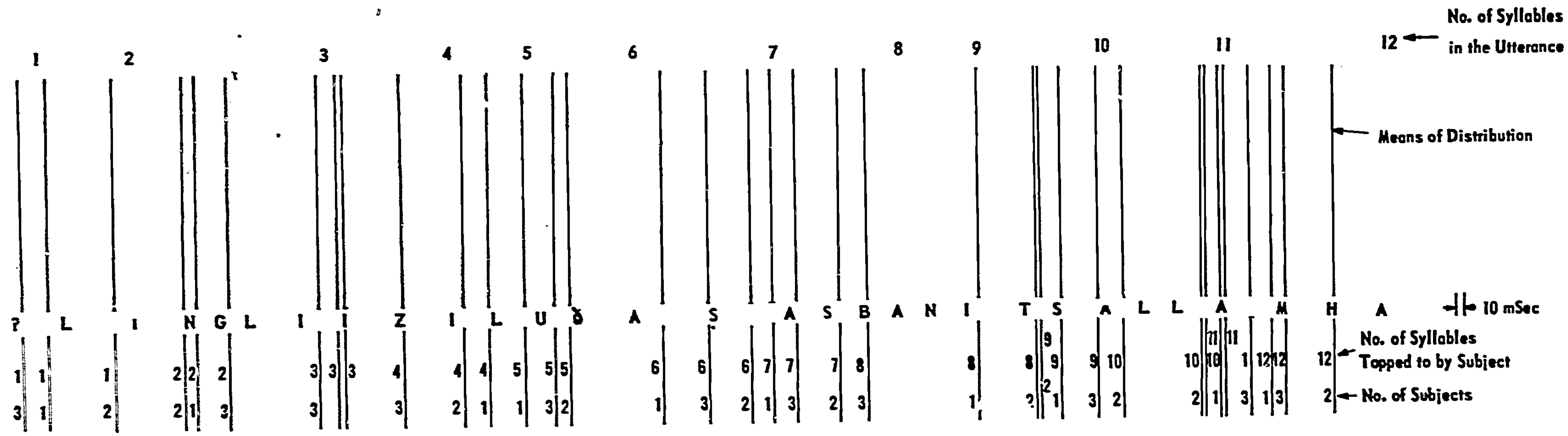


Fig. 3. An illustration of rhythmic vs. non-rhythmic syllables in the CJA utterance.

TABLE 2

PLACEMENT OF Ss TAPS ON THE SYLLABLES OF UTTERANCE 1

	ba	hib	bit	gaa	bil	za	mii	li	fa	riid
S_1		1	1	1		1	1		1	1
S_2		1		1	1		1			1
S_3		1		1		1	1		1	1

TABLE 3

PLACEMENT OF Ss TAPS ON THE SYLLABLES OF UTTERANCE 3

	ʔi	ling	lii	zi	lu	ɣ a	saʕ	ba	nit	ʕal	lam	ha
S_1	1	1	1		1	1	1		1		1	
S_2		1	1		1		1			1	1	
S_3	1		1	1	1		1				1	

3.4 Relative Pitch Levels

After examining levels of pitch in contrastive environments where only the difference in pitch levels changes the meaning of the utterances, three relative levels of pitch were assumed to operate in the intonation system of CJA. The following examples, taken from the corpus of data, show two of the CJA levels of pitch in contrast. Compare this pair of utterances:

1. (ʔi)š̌šuu ʔisim ʔaxuu?
   3- "2-3 '2-3 "3-3/
   (Normal question)

   'What's his brother's name?'

2. (ʔi)š̌šuu ʔisim ʔaxuu?
   3- "2-3 '2-3- "3-2//
   (Echo question)

   'What's his brother's name?'

The difference in meaning of the two utterances is signaled by the contrastive pitches of the last syllables ("3-3, "3-2). The pitch that falls on the last syllable xuu in the second utterance is relatively higher than the pitch that falls on the same syllable in the first utterance. This established the existence of two contrasting pitch levels in CJA, neither of which fall within the frequency range of "low", in terms of GAE normal adult frequency. For the convenience of comparison with GAE pitch levels, I will follow Pike's numbering system (using the smallest number for the highest pitch and the largest number for the lowest pitch), and assign number 3 to the pitch in the first utterance and call it "pitch level /3/", and number 2 to the pitch in the second utterance, which is higher, and call it "pitch level /2/". (See Fig. 4)

Compare the following:

2. (ʔi)š̌šuu ʔisim ʔaxuu?
   3- "2-3 '2-3 "3-2/
   (Echo question)

3 (ʔi)šṧuu ʔisim ʔaxuu?
3- "2-3 '2-3- "3-1-3↗/
(Repeated with surprise)

Both utterances are questions; but they have different meanings. Number two indicates an echo question, whereas number three indicates a question repeated with surprised attention. This difference in meaning is due to the difference in the levels of pitch included in the intonation contours that mark the end of the two questions. The meaning of surprised attention is expressed in number three by a pitch higher than the pitch heard at the end of the echo question. This validates the contrast between pitch level /2/ and another pitch that is higher in comparison, and at the same time establishes the existence of a third pitch in CJA, which I will call "pitch level /1/".

Thus the existence of three relative pitch levels in CJA is established (see Fig. 4). The three levels of pitch in CJA are relative but not absolute. They are not at equal intervals in relation to each other and the difference between the intervals varies from individual to individual.[8]

As in GAE, these pitches are meaningless by themselves. They combine with one another in order to form intonation contours which are crucial to the meaning of an utterance. Analysis of the corpus of data shows the existence of the following types of contours in the intonation system of CJA: (1) falling contours, (2) rising contours, (3) level contours, (4) rising-falling contours, (5) rising-falling-rising contours. Examples of these types of contours and a description of each, will be given in the section that follows.[9]

---

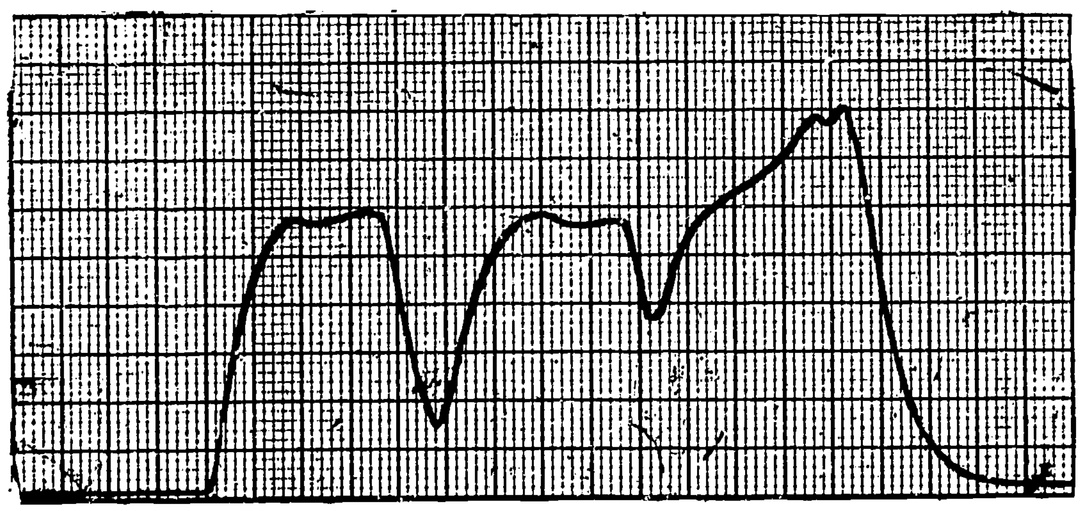
[8]The supporting evidence for this statement is not included for reasons of brevity. It was arrived at from acoustic analyses of the CJA-translation-equivalents of the selected English utterances.

[9]See pp. 42-46.

PITCH /3/

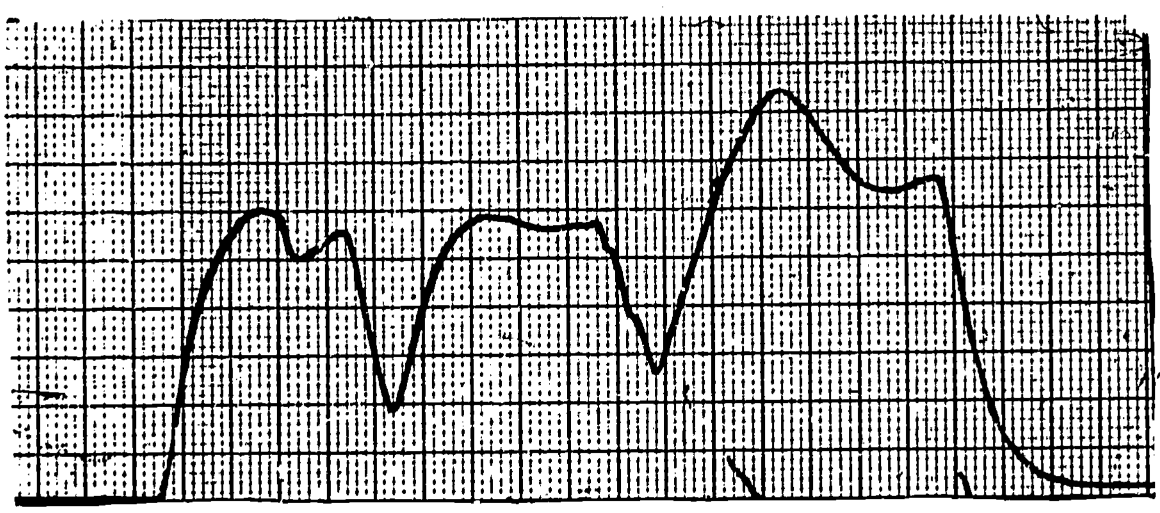
Š Š U U ʔI S I M ʔ A X U U

PITCH /2/



Š Š U U ʔ I S I M ʔ A X U U

PITCH /1/



Š Š U U ʔ I S I M ʔ A X U U

Fig. 4. An illustration of the three levels of pitch in CJA.

CJA intonation contours vary in their length. They cover syllables, words and sometimes the whole phrase or utterance, as in the following:

1. gulli~ ššuu biddak tiʕmal.
   "2-3- "2-3- "2- 3 //

   'Tell me what you're going to do.'

2. raayḥi~tkuun hooni~lfasli~jjaay?
   3- "2- -2/.

   'Will you be here next semester?'

3. saḥiiḥ bitḥibb tuukul ʔakil ʕarabi.
   3-"2- -2/.

   'Do you really like to eat Arab food?'

Like the intonation system of Egyptian Colloquial Arabic, the intonation contours in CJA do not always express specific meanings that are attached to them[10]. In my data, there are some intonation contours that signal specific meanings and others that do not. The CJA intonation contour "1-3, for example, signals contrastive pointing plus surprised attention. Observe the following:

1. ṣaarlu byudrusi~ngliizi~ḥdaʕšar sana.
   "2- 3- "2-3- "2-3- "1-3- '2-3//

   'He's been studying English for eleven years.'
   (Emphasis on the number of years)

2. ʔilingliizi luɣa ṣaʕba nitʕallamha.
   "2-3- "2-3 "1-3↗/

   'English is a difficult language to learn!'
   (Repeated with surprise)

On the other hand, the CJA intonation contour "3-2 always signals questions. For example:

1. mišheek?
   3-"3- 2/.
   (Confirmatory attached question)

   'Doesn't he?'

---

[10] Abdallah, G. op. cit. pp. 95-96, 99.

2. raayhi~tkuun hooni~lfasli~jjaay?
"3- 3- "2-3- "3-. 2/
(Next semester in contrast with this semester).
'Will you be here next semester?'

An important feature of pitch in CJA is the occurrence of three levels of pitch in all positions in a pause group. These levels may occur initially, medially, or finally as illustrated in the section that follows.

It is very important to add that tracing the pitch change (in spectrograms and strip charts) of some of the utterances selected for analysis for English informants and Ss shows a fundamental difference between the direction and duration of intonational glides in GAE and CJA. In GAE, a glide may spread over one vowel phoneme or a sequence of vowels, with slight, smooth changes from one vowel to the other. The length of time occupied by each glide is dependent on the number of vowels the glide covers.[11] On the other hand, a glide in CJA occurs on one vowel phoneme at a time, with abrupt quick change from one vowel to the other. This explains why falling-rising and rising-falling intonation contours are not common in CJA.[12]

3.5 Primary Contours in CJA as Included in My Data[13]

1. Falling Contours:

a. Primary Contour "1-3

This primary contour occurs, in my data, in pause group non-final and final positions. It occurs with and without precontours. It indicates unexpectedness, contrastive pointing plus surprised attention. The following examples illustrate this contour:

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[11] See Pike, K. L. Tone languages. p. 58.

[12] See Table 4, p. 47.

[13] See Table 4, p. 47.

1. ʔilingliizi luɣa ṣaʕba nitʕallamha.
   3- "2-3- "2-3 "1-3↗/
   (Repeated with surprise)

   'English is a difficult language to learn!'

2. fahd ʕaaš ḥayaa~mliiḥa,bas ʔaxuu maa ʕaaš
   "1-3 "2- 3- "3 -3 /3- "2-3-"2-3 -3//

   'Fahd had lived a comfortable life, but his brother hadn't.'

b. Primary Contour "2-3:

This contour has no restrictions on its occurrence. It occurs with and without precontours. When it is preceded by a precontour, it is often that of pitch level /3/. It implies mild contrastive pointing and non-finality when it occurs non-finally; but, it has the meaning of finality when it occurs in final pause group position. In the latter case, it is followed by a pause that is longer than in the former position. Examples of this "2-3 contour are:

1. kiif ḥaalak?
   '3 -3 "2- 3- /
   (Normal greeting)

   'How are you?'

2. tagriiban θamaanya wʕišriin miil.
   3- "2-3- "2-3- "2-3 "2-3//

   'It's about twenty-eight miles.'

3. (ʔi)ššuu bitḥibb tuukil ya sayyid?
   3- "2-3- "2-3- "3-2 /
   (Giving choice)

   'What would you like to eat, sir?'

This contour is the most common one in CJA. When this contour occurs finally, it makes CJA utterances sound incomplete to American English listeners who in speaking Arabic substitute their American English "2-4 final contour instead.

2. Rising Contours

a. Primary Contour "2-1:

This primary contour occurs once in my data, in non-final position in a pause group. It indicates incompleteness, and unexpectedness.

Example:

ʔiiš! mahdi! ʔanaa maa baṣaddig haššiiʔ.
"1- 3/ "2- 1/ 3- "2-3 "2-3- "2-3//

'What! Mahdi! I can't believe that.'

b. Primary Contour "3-1:

There is only one example of this contour in my data, occurring with a pitch level /3/ precontour preceding. This contour signals disbelief and extreme tentativeness as well as unexpectedness.

Example:

mišheek?
3-"3-1 /
(Asking for information)

'Doesn't he?' (Isn't he?)

c. Primary Contour "3-2:

This contour occurs finally in pause group position. In most of its occurrences, it is preceded by precontours of pitch level /3/. It signals incompleteness and, like the American English primary contour "3-2, at the end of a pause group, it represents a question which requires an answer. A statement given this intonation pattern without any other signal necessary, indicates a question. Accompanied by emphatic stress, it adds intensity and a feeling of unexpectedness. Here are some examples:

1. mišheek?
3-"3- 2 /
(Confirmatory attached question)

'Doesn't he?' (Isn't it?)

2. majabši~lboosṭaji~lmaktuubi~mbaariḥ?
   3-"2-3- "2-3- "2-3- "3- -2/
   (Asking with surprise)

   'Didn't the mailman deliver the letter yesterday?'

3. raayḥi~tkuun hooni~lfaṣli~jjaay?
   "3- 3- "1-3- "3-2 /
   (Next semester in contrast with this semester)

   'Will you be here next semester?

3. Level Contours

a. Primary Contour "3-3:

This contour, as "2-3, occurs in CJA in all positions in pause groups. It gives the meaning of continuity and coherence, with no other particular significance.

1. raayḥi~tkuun hooni~lfaṣli~jjaay?
   "3 -3- "1-3- "3-2 /
   (Next semester in contrast with this semester)

   'Will you be here next semester?'

2. ʔistanna dagiiga.
   3-"2-3- "3-3- //
   (Normal request)

   'Wait a minute.'

b. Primary Contour "2-2:

This contour occurs in non-final and final positions in pause groups. It often follows precontours of pitch level /3/. It indicates incompleteness, moderate contrastive pointing, and strong implication of expectedness at the end of a pause group, as illustrated in the following examples:

1. fahd ʕaaš ḥayaa~mliiḥa, bas ʔaxuu maa ʕaaš
   3- "2-2 3- "3-3 / "2-3-2-3 -3//
   (Emphasis on had and hadn't)

   'Fahd had lived a comfortable life, but his brother hadn't.'

2. raayḥi~tkuun hooni~lfaṣli~jjaay?
"3-3- "2-3- "2- -2/
(Next semester but not next year)
'Will you be here next semester?'

3. ṣaḥiiḥ bitḥibbtuukil ʔakil ʕarabi?
3-"2- -2/
(Is it true?)
'Do you really like to eat Arab food?'

4. Rising-falling "3-2-3

This contour occurs once in my data in pause group final position, preceded by precontour of pitch level /3/. It signals friendliness and liveliness, as in the following greeting:

ṣabaaḥi~lxeer ya wilyam.
3- "3-2-3- -3//

'Good Morning, William!'

5. Rising-falling-rising "3-1-3↗ [14]

There is only one example of this contour occurring in final position. It gives the meaning of unexpectedness mixed with surprised attention.

(ʔi)ššuu ʔisim ʔaxuu?
3- "3-1 '2-3 "3-1-3↗ /.
(Question repeated with surprise)

'What's his brother's name?'

[14] For contrast, compare this rising-falling-rising "3-1-3↗ intonation with the preceding CJA rising-falling "3-2-3 intonation.

TABLE 4

SUMMARY OF CJA PRIMARY CONTOURS
INCLUDED IN THE CORPUS OF DATA

Type	Number	Type	Number	Type	Number	Type	Number	Type	Number
1. <u>Falling</u>		2. <u>Rising</u>		3. <u>Level</u>		4. <u>Falling-Rising</u>		5. <u>Rising-Falling</u>	
1-3	10	3-1	1	3-3	9	None		3-1-3↗	1
2-3	117	3-2	15	2-2	4			3-2-3	1
		2-1	1						
Sub-total	127		17		13		--		2
Total	159								

CHAPTER FOUR

CONTRASTIVE ANALYSIS OF THE PROSODY OF GAE AND CJA

In this chapter a comparative analysis of the prosodic features of GAE and CJA will be presented, based on the descriptions given in the preceding chapters. Emphasis will be placed on the major problems involved in the learning of prosodic features of GAE by Jordanian students.

The problems pinpointed will be presented in turn in the following order:

a. indication of the error involved;

b. description of the error;

c. interpretation of the error (where possible) in relation to any difference, found in this research, between the prosodic patterns of GAE and CJA. The presentation of each error will be illustrated by examples taken from data.

2.1 Stress Patterns

Both GAE and CJA have three degrees of stress determined according to their position in the words. For the convenience of comparison, these three stresses are defined and transcribed the same way in the two languages: primary stress /´/, secondary stress /`/, and weak stress /˘/. On the sentence level both GAE and CJA use the three stresses mentioned above plus a louder one. This louder stress is movable according to the speaker's intention and is described in terms of sentences. It is transcribed here as /"/.

Unlike GAE, where stress in words is phonemic, the position of word stress in CJA is non-phonemic. Attempts to locate a minimal pair of words, in which the difference in stress caused the meanings of the two words to differ , as in the case of GAE, were completely fruitless.

Dissimilarities between stress patterns in the two languages produce some difficulty for the Jordanian students when they try to learn GAE. Below are some of these major problems:

Problem 1: The Jordanian Ss substituted primary or secondary stress for a weak stress when they produced GAE utterances. Note the following:

a. M: I visited America in nineteen fifty-seven.

S: Ì vísited América in ninetéen fífty-sèven.

CJA: zúrt ʔaméerka sànt ʔálfu wtisiʕmíyya wsábʕa wxamsiin.

b. M: May I have another cup of tea, plèase.

S: Mây Ì háve ánother cúp of tea, pléase.

CJA: mímkin ʔáaxuð kubbáyit šáay θáanya law samáḥt.

Although in both GAE and CJA the word or words on which sentence stress falls becomes the most prominent part in the sentence, while other stresses are reduced, a fundamental difference still exists between the two languages. In GAE, under the influence of sentence stress, all the other lexical stresses in the utterance lose their significance and are reduced to secondary and sometimes weak stress. On the other hand, CJA lexical items not receiving the sentence stress either keep their citation form stress or are reduced only to secondary stress. There are very few cases where primary word stresses are reduced to weak stress (See Figs. 5 and 6). Notice also how in the examples given above, all the words of the CJA translation-equivalent receive primary or secondary stresses.

Problem 2: The Ss pronounced GAE monosyllabic words loudly and with primary stress, when used in conversational speech. They produced the

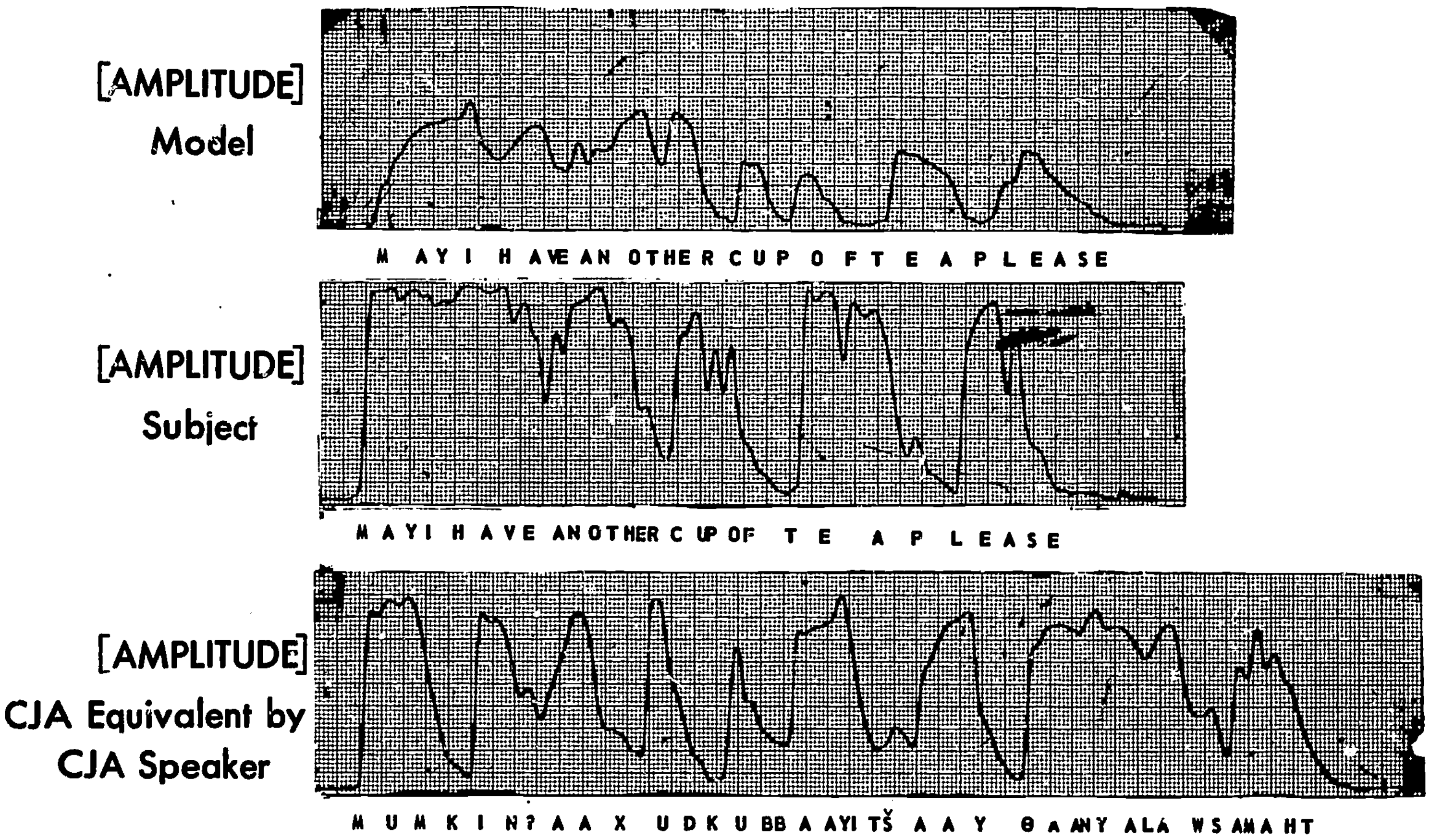

Fig. 5. An illustration showing how the Jordanian S gives primary or secondary stress to the words of the English utterance.

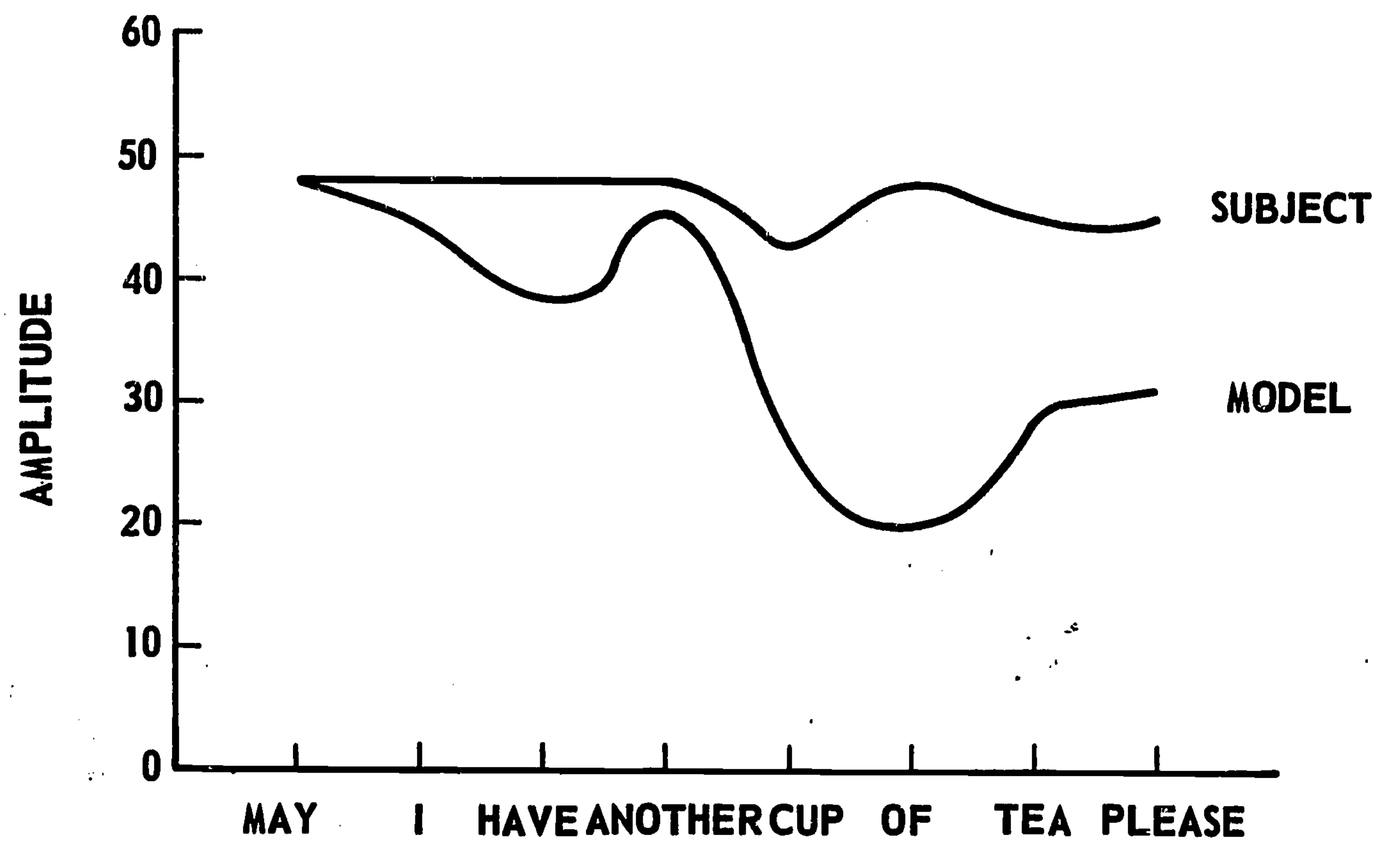

Fig. 6. Data based on Fig. 5 showing amplitude relative to highest value on same scale, for M and S.

stressed forms of these words instead of the unstressed forms that appear in the GAE data. Here are some examples.

a. M: He's been studying English for eleven years.

S: He's [hi hæz] been studying English for eleven years.

b. M: How are you [aryə]?

S: How are you [a:ryu]?

The distribution of stresses within words, phrases, and sentences is not the same in GAE and CJA. Each language has its own patterns. Even though word stress patterns in the two languages are alike in the case of monosyllabic words,[1] there is still some difficulty resulting from the distribution of these patterns. GAE monosyllabic words, included in my data, such as:

"am, is, are, has, have, had, you, his, them, to, of, for" receive primary stress when pronounced in isolation, or when put under special emphasis in an utterance; and weak stress accompanied by reduction of some phonemes, when they occur in a normal connected conversation. Parallel patterns in CJA do not follow the same pattern of distribution, especially where reduction of stress in GAE has influence of the phonetic features of the stressed syllables.

The tendency of the Ss to give the stressed rather than the unstressed forms of the monosyllabic words mentioned above, could also be related to the way the Ss were introduced to English. Jordanian students are generally taught the stressed forms of the verb "to be," the verb "to have" and some others in our schools. Furthermore, they practice these stressed forms loudly so that they become accustomed to producing them stressed whenever they see them. (See Fig. 7)

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[1]In both languages monosyllabic words are strongly stressed in isolation or under special emphasis.

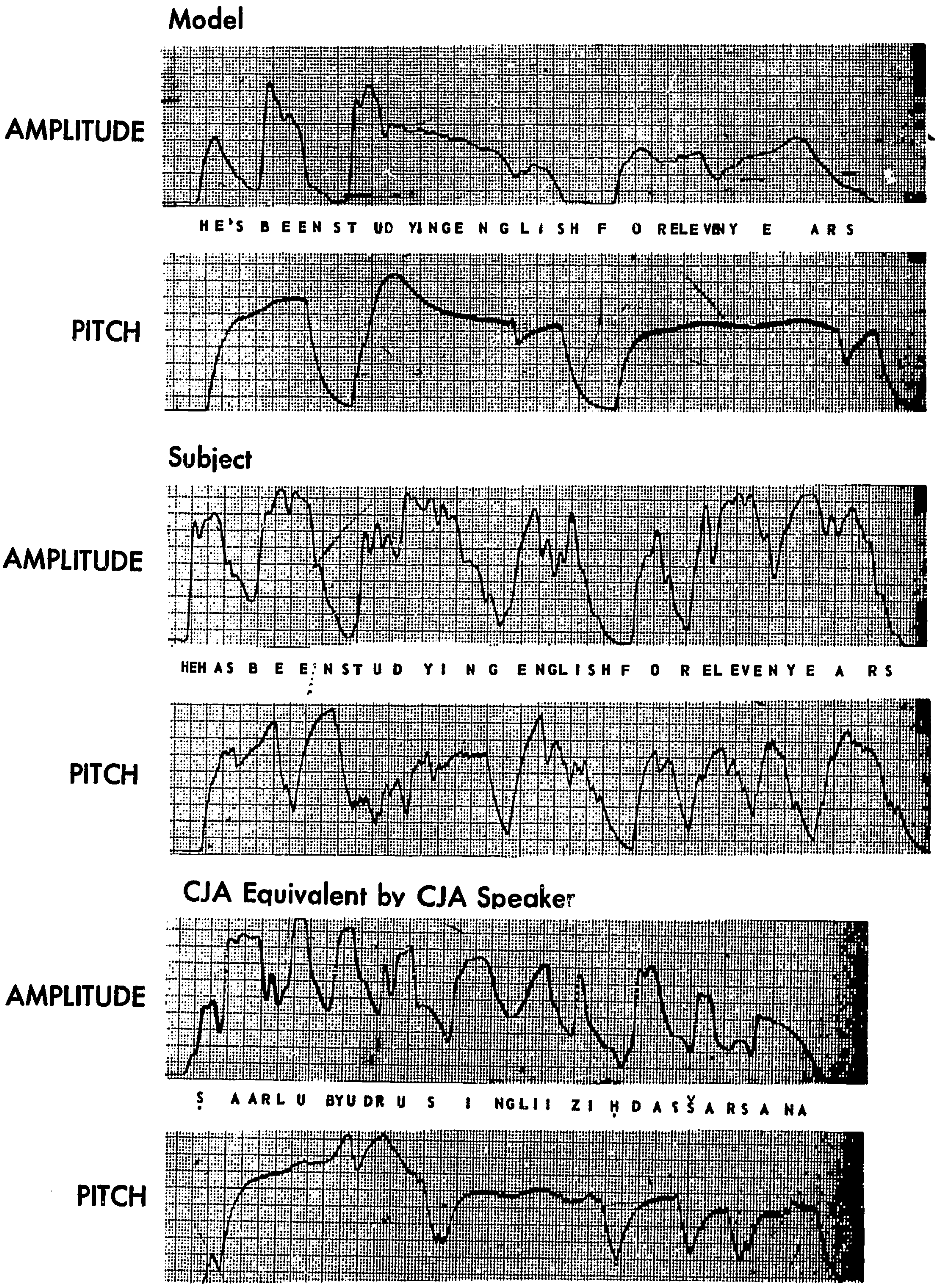

Fig. 7. An example of how GAE reduced forms are produced in their full forms by the S.

Problem 3: The Ss placed primary stress on the second syllable and secondary stress on the first syllable of disyllabic GAE compound words:

roòmmáte (see Fig. 8)

nìnetéen

The fact that CJA does not stress and unstress in the GAE way, makes it difficult for the Ss to produce some GAE stress patterns with accuracy. The Ss would always carry over their own patterns in which the placement of stresses is systematic and predictable.

The usual stress pattern, for example, of compound disyllabic words in GAE gives primary stress to the first syllable and secondary stress to the second.[2] There is no such thing as a phonemic distinction in GAE between long and short syllables. The Ss considered this stress pattern as parallel to their pattern for words containing VV, where the first combination of VV from the end of the word is given primary stress.[3]

Problem 4: The Ss pronounced some GAE words consisting of three syllables incorrectly, by substituting primary stress for weak and secondary stress for primary as in the word:

"yèsterdáy"

The different stress patterns in each language are responsible for the incorrect pronunciation of GAE words consisting of three syllables. These syllables were interpreted by the Jordanian Ss as quantitatively long or short. The comparable stress pattern in CJA gives primary stress to the syllable interpreted as being long and

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[2]See P, 15.

[3]See Pp. 26-27.

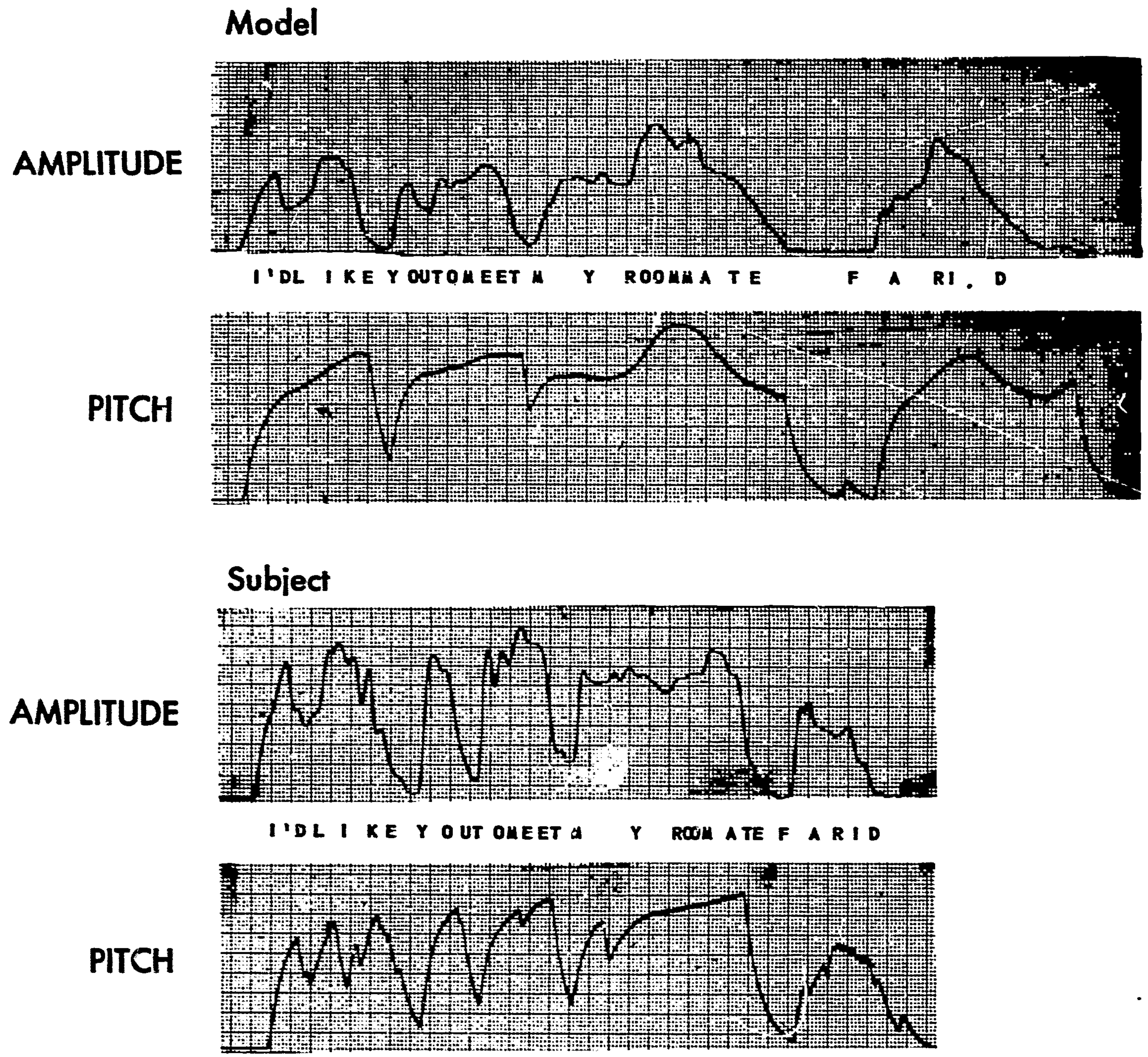

Fig. 8. Graphs showing difference, with respect to changes in loudness and pitch, between M and S in pronouncing the syllables of the compound word roommate.

weak or secondary stresses to the others; whereas word stress in GAE does not consider the relative length of syllables.[4] The fact that Jordanian speakers are sensitive to the relative length of syllables and the vowels involved, causes them to put primary stress on the syllable day which they interpret as long and secondary and weak stresses respectively on the other two syllables interpreted as short. (See Fig. 9)

Problem 5: The Ss produced GAE words consisting of four syllables incorrectly by changing the weak stress to primary and primary stress to secondary. This is illustrated in the following example:

"còmfórtable"

The Ss had special difficulty in placing stress in GAE words of four or more syllables. Influenced by their language stress habits, they pronounced the word comfortable with primary stress on the first combination VCC ort instead of the first syllable com. (See Fig. 10)

Problem 6: The Ss mispronounced some GAE words of three syllables by substituting primary stress for weak stress and vice versa. Observe the following:

éleven

déliver

ánother

According to a common stress pattern in GAE, some words containing three syllables have primary stress on the second syllable and weak stresses on the rest.[5] The parallel pattern in CJA uses primary stress on the first syllable since the combination of VCC or VV is lacking

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[4]See Pp. 14-15.

[5]See P. 15.

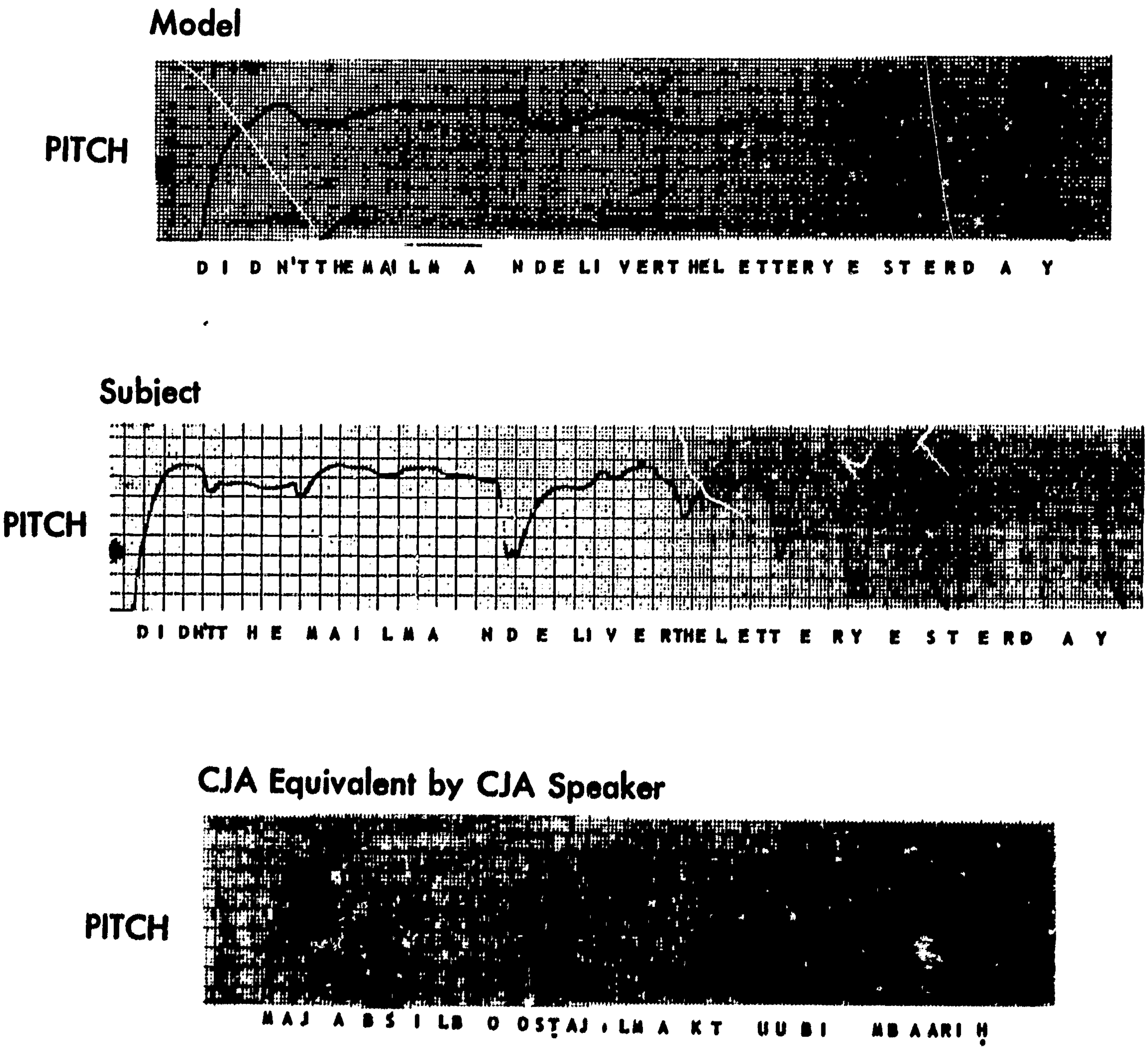

Fig. 9. A graphic representation of the incorrect placement of word stress by the S.

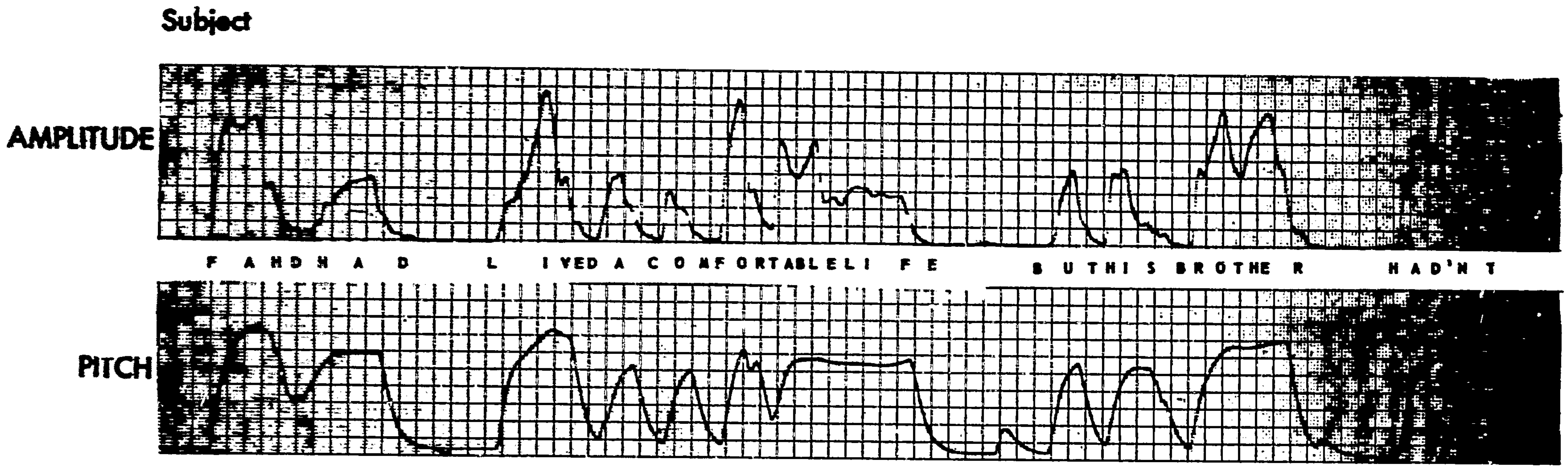

Fig. 10. An example showing the tendency of the Ss to give primary stress to syllables containing what they interpret as long vowels VV.

here.[6] This pattern influenced the Ss to pronounce the words mentioned above incorrectly by placing primary stresses on the first rather than the second syllables.

Problem 7: The Ss shortened GAE syllables receiving primary or sentence stress and lengthened syllables receiving weak stress.

a. M: I'd like you to meet my róommate, Farid.

S: I'd like you to meet my roommáte, Farid.

b. M: Fahd had lived a cómfortable life, but his brother hadn't.

S: Fahd had lived a comfórtable life but his brother hadn't.

As indicated previously one of the features of GAE stress patterns is that syllables under primary stress or at the center of an intonation pattern are generally pronounced longer than syllables under weak stress.[7] For example, the syllables room and com in the words roommate and comfortable were pronounced longer by the English models than other syllables in the two utterances given above.

Influenced by CJA features of stress which are different from those of GAE, the Ss pronounced the syllables mate and for in the words roommate and comfortable longer than the syllables room and com. They were shortened along with the shifting of primary stress to mate and for.[8] This is illustrated in Fig. 11.

2.2 Rhythm Patterns

Problem 1: The fact that rhythm in GAE is "phrase stress-timed" and in CJA "word stress-timed," gave some trouble to the Ss in understanding

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[6]See Pp. 26-27.

[7]See P. 16.

[8]See Pp. 26-27.

SPEAKER	WORD	SYLLABLE	TIME IN SECONDS
Model	roommate roommate	room mate	.15 .1
Subject	roommate roommate	room mate	.075 .125
Model	comfortable comfortable	com for	.19 .05
Subject	comfortable comfortable	com for	.09 .15

Fig. 11. Data based on Figures 8 and 17 showing the difference, with respect to tempo, between M and S in pronouncing the syllables room and mate in the word roommate, and the syllables com and for in the word comfortable.

and producing GAE utterances correctly. Following are some of the Ss trouble spots:

a. M: Didn't the mailman + deliver the letter + yesterday?
(Yesterday not the day before)

S: Didn't + the mailman + deliver + the letter + yesterday?

b. M: Will you be + here + next semester?

S: Will + you + be + here + next + semester?

There is no evidence in the CJA rhythm system for either reduction in the number of syllables or prolongation of syllables in rhythm groups as in the case of GAE. Thus the Ss pronounced all the GAE words in the foregoing examples clearly and loudly, carrying over their language rhythm habits. The comparable CJA rhythm patterns of the preceding GAE examples are given below for illustration:

a. Didn't + the mailman + deliver + the letter + yesterday?
majabši+~lboosṭaji+~lmaktuubi+~mbaariḥ?

b. Will + you + be + here + next + semester?
raayḥi+~tkuun+hooni+~lfaṣli+~jjaay?

(See Fig. 12)

Problem 2: The Ss had difficulty in producing reduced forms in GAE connected speech:

Example:

a. M: He's been studying English for eleven years.

S: He's [hi haez] been studying English for eleven years.

As pointed out earlier in the section on stress patterns in GAE, there are some words which appear in reduced forms in rapid connected speech.[9] CJA does not have comparable reduced forms in its stress or

[9] See Pp. 15-16.

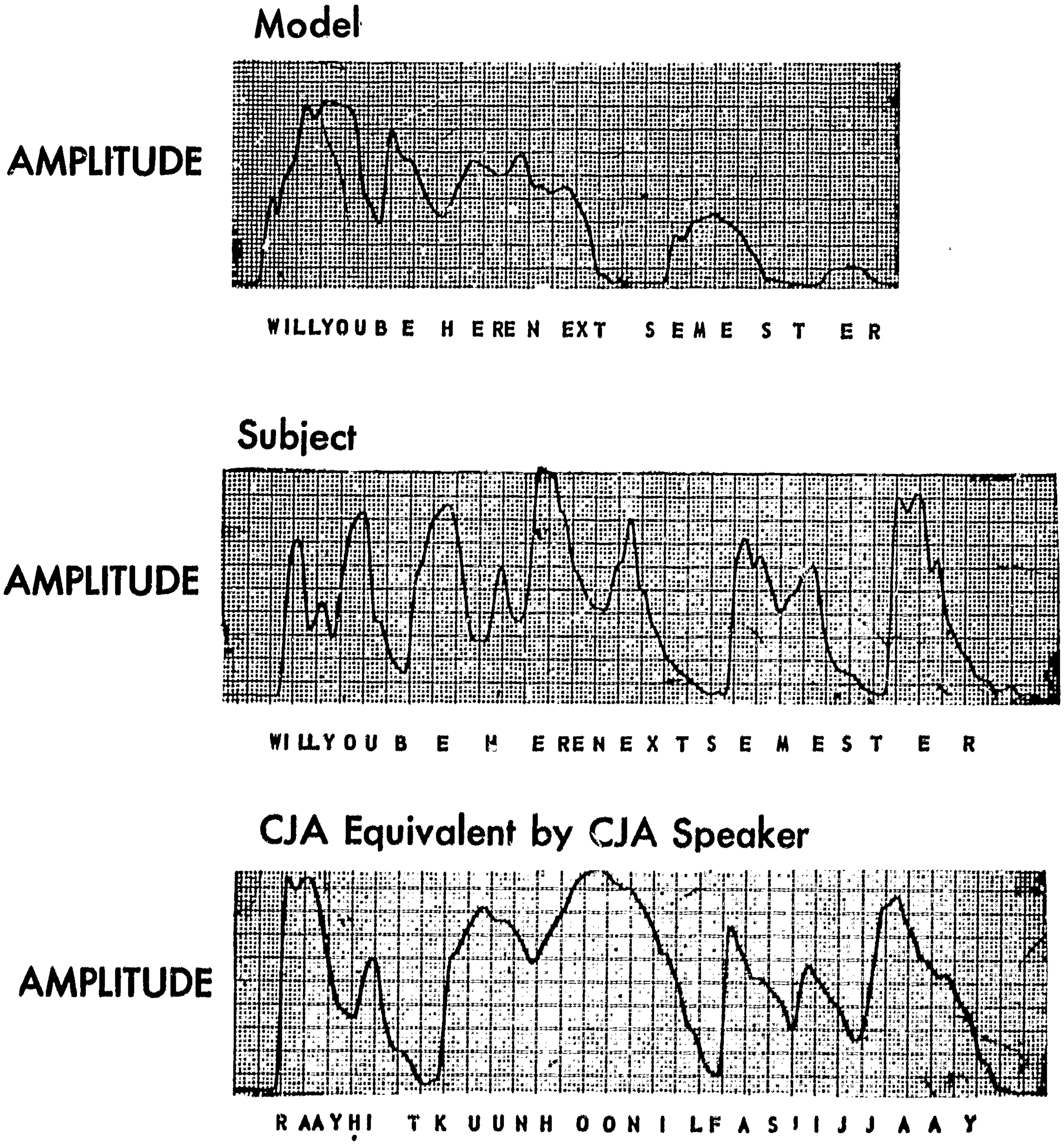

Fig. 12. An illustration of CJA "word-stressed timed rhythm".

rhythm system. The Ss pronounced some of the reduced forms fully and clearly, giving them their citation value in terms of length and stress. (See Fig. 4).

The rhythm habits of CJA made English utterances, produced by Jordanian speakers, sound tense and unrelaxed. Native speakers of GAE may think that Jordanian speakers are a little bit irritated when they speak English.

2.3 Intonation Patterns

Before indicating and interpreting the Ss' errors of intonation, a word about the order of presentation is appropriate. The errors are grouped in categories, each one including those utterances that appeared to be of the same type. The order in which these categories are presented is based on:

1. Their relative frequency in daily communication.
2. Their degree of relevance to Jordanian students learning English.
3. The degree of facilitation and interference involved in the intonation patterns of each category.

In view of all these points, the intonation errors discovered in this research are presented in the following categories:

1. Greetings
2. Statements
3. Yes-no questions
4. Wh-questions
5. Requests and commands
6. Exclamatory sentences
7. Attached questions

It should be noted that the English examples given for illustration under 'Description of problems' were all numbered for intonation contours as performed by the English M, whereas the English examples presented in the section 'Interpretation of errors' were numbered as produced by the Ss.

1. Greetings

a. "Good morning."

Problems: Intonation patterns "2-4 final, "2-1-4 final, "2--4 final.

Description of problems: A speaker of GAE uses the falling intonation "2--4 which extends over the whole phrase, when he greets another person in a lively cheerful manner. Responding to a greeting in a friendly manner, he uses the rising-falling intonation "2-1-4, and when the greeting is a normal one, the ordinary falling contour "2-4 is used.

On the other hand, CJA uses the falling intonation "2-3 for greetings of the first and third types, and the rising-falling intonation "3-2-3 for a greeting spoken in a friendly way. For example:

1) a) Good morning, Sami.
"2- -4/ "3-3//
(Very lively and cheerful)

b) ṣabaaḥi~lxeer fariid.
3- "2-3- -3//

2) a) Good morning, William.
3- "2-1-4 -4//
(Rather friendly)

b) ṣabaaḥi~lxeer ya wilyam.
3- "3-2-3- -3//

3) a) Good morning, Farid.
3- "2-4- -4//

b) ṣabaaḥi~lxeer fariid.
3- "2-3- -3//

Interpretation of errors: As noted above, both the falling and the rising-falling intonations used for greetings in GAE are also used in CJA greetings, but in a different way. The ending points of CJA intonations do not drop to pitch level /4/ as in GAE, but to pitch level /3/ which is the lowest pitch in CJA. This difference in form between greeting intonations in GAE and CJA has given all the Ss some trouble in producing GAE intonations. They substituted their intonation "2-3 for the GAE intonations "2--4 and "2-4 in the first and the third examples. (See Fig. 13) This made them sound somewhat curt to native English speakers. As for the second type "2-1-4, it was changed to "3-2-3 after the comparable CJA pattern for this situation.

Note the following utterances as performed by the Ss:

1) a) Good morning, Sami.
3- "2-3- -3//
(Trying to be lively and cheerful)

ṣabaaḥi~lxeer, saami.
3- "2-3- -3//

2) a) Good morning, William.
3- "3-2-3- -3//
(Rather friendly)

ṣabaaḥi~lxeer ya wilyam.
3- "3-2-3- -3//

3) a) Good morning, Farid.
3- "2-3- -3//
(Trying to be normal)

ṣabaaḥi~lxeer fariid.
3- "2-3- -3//

b. "How are you?"

Problems: Intonation patterns "2-4 final, "2--4 final.

Description of problems: In GAE, the first of two speakers generally raises his pitch on are, producing a "2-4 intonation pattern when he

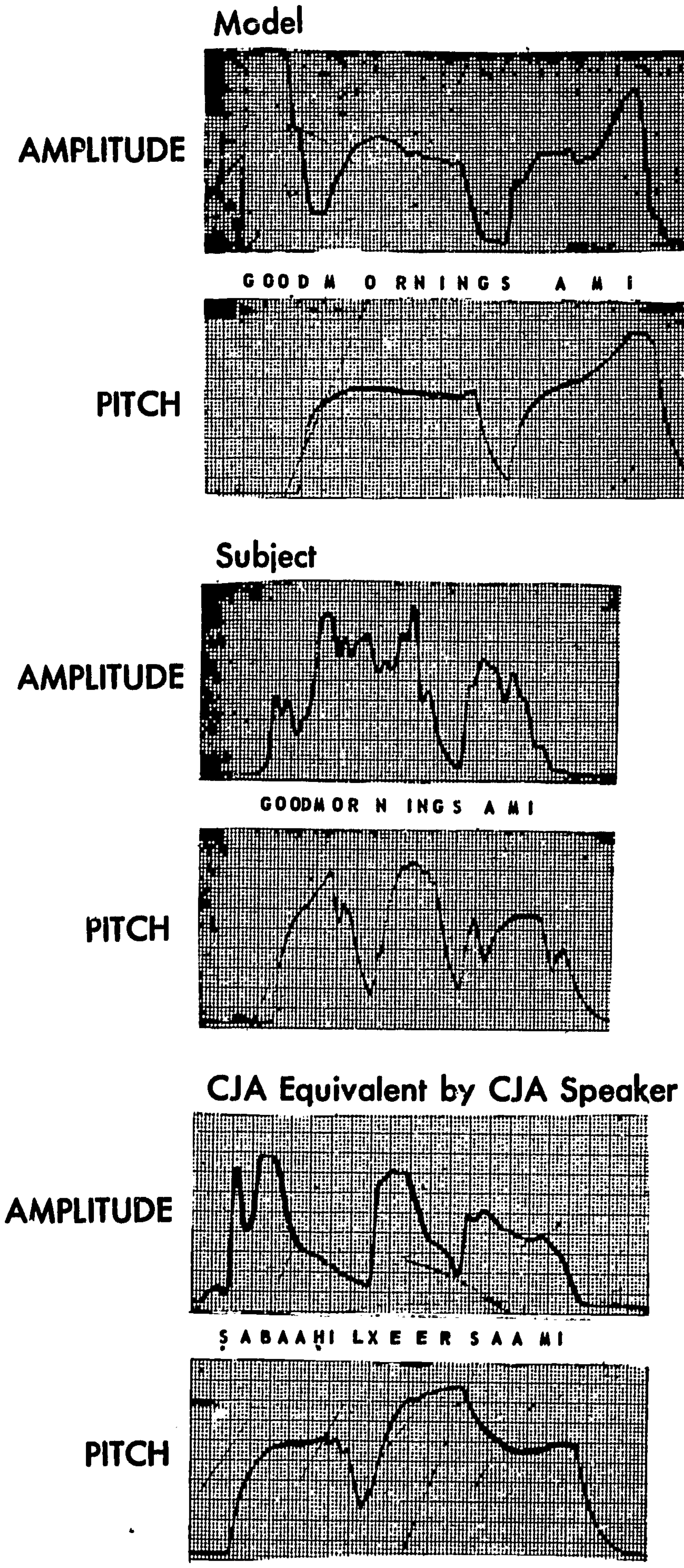

Fig. 13. Non-resemblance of the two graphs for M and S, illustrates how the S produces the English greeting with a different pitch contour from the M.

uses this greeting. The person who replies often repeats the same greeting; but this time, he raises his pitch on you which becomes the center of attention, using the same intonation "2-4. In normal greetings, some speakers spread the falling intonation "2--4 over the whole phrase are you.

In contrast, speakers of CJA use a high pitch register on the interrogative word kiif 'how?'; then, they use still a higher pitch on the first syllable of ḥaalak 'your condition - (you)', and finally their intonation falls on the second syllable of ḥaalak. In response, the second speaker sometimes starts the question with the word winta 'and you' which he adds to bring into contrast the person he is addressing. The word added, i.e., winta receives the highest pitch and the strongest stress in the utterance, while the rest of the utterance becomes secondary in importance. On information occasions, speakers lower their pitch on kiif 'how' and raise it on the first syllable of ḥaalak 'your condition (you), and then they let it fall at the end of the second syllable. For example:

1) a) How are you?
3- "2-4 -4/.
(First of two speakers)

b) kiif haalak?
'2-3 "2-3-/.

2) a) How are you?
3- "2-4/.
(Second speaker in response)

b) winta kiif ḥaalak?
"2-3- '2-3- "2-3-/

3) a) How are you?
3- "2- -4/
(Informal greeting)

b) kiif ḥaalak?
3- "2-3- /

Interpretation of errors: The falling primary intonation "2-4, occurring finally, is used for greeting in GAE by the first speaker. The same greeting with the same meaning is expressed by the falling primary intonation "2-3, occurring finally in CJA.

Similarly, the intonation contour "2-4, in final position, signals greeting in GAE as a response used by the second speaker. In this case the pronoun you is brought into the center of attention. CJA signals this meaning by the addition of the word winta 'and you' which is placed at the beginning of the greeting, carrying the intonation pattern "2-3.

Informal greetings in GAE are indicated by the stretch of the pattern "2--4 over the whole phrase are you. There is no similar intonation pattern in CJA, since words are not reduced as in GAE. Instead, there is a reduction of pitch and stress on the interrogative word kiif 'how' and a rise of pitch on ḥaaḷak which falls under the primary contour "2-3.

The four Ss, influenced by comparable intonation patterns in CJA raised their pitch on the interrogative word how as well as are in the first two utterances. In the second type, where GAE uses a rise in pitch on you, they missed the point because CJA uses a different structure for this type of greeting in order to bring into contrast the person addressed. As mentioned above, the CJA equivalent pattern includes the addition of the word winta 'and you' which receives the primary intonation "2-3. (See Fig. 14)

The third type, "2--4, is replaced by the CJA "2-3 intonation in final position, since CJA does not have intonations that stretch over reduced syllables and then drop down to pitch level /4/. Here are examples of English utterances as attempted by the Ss:

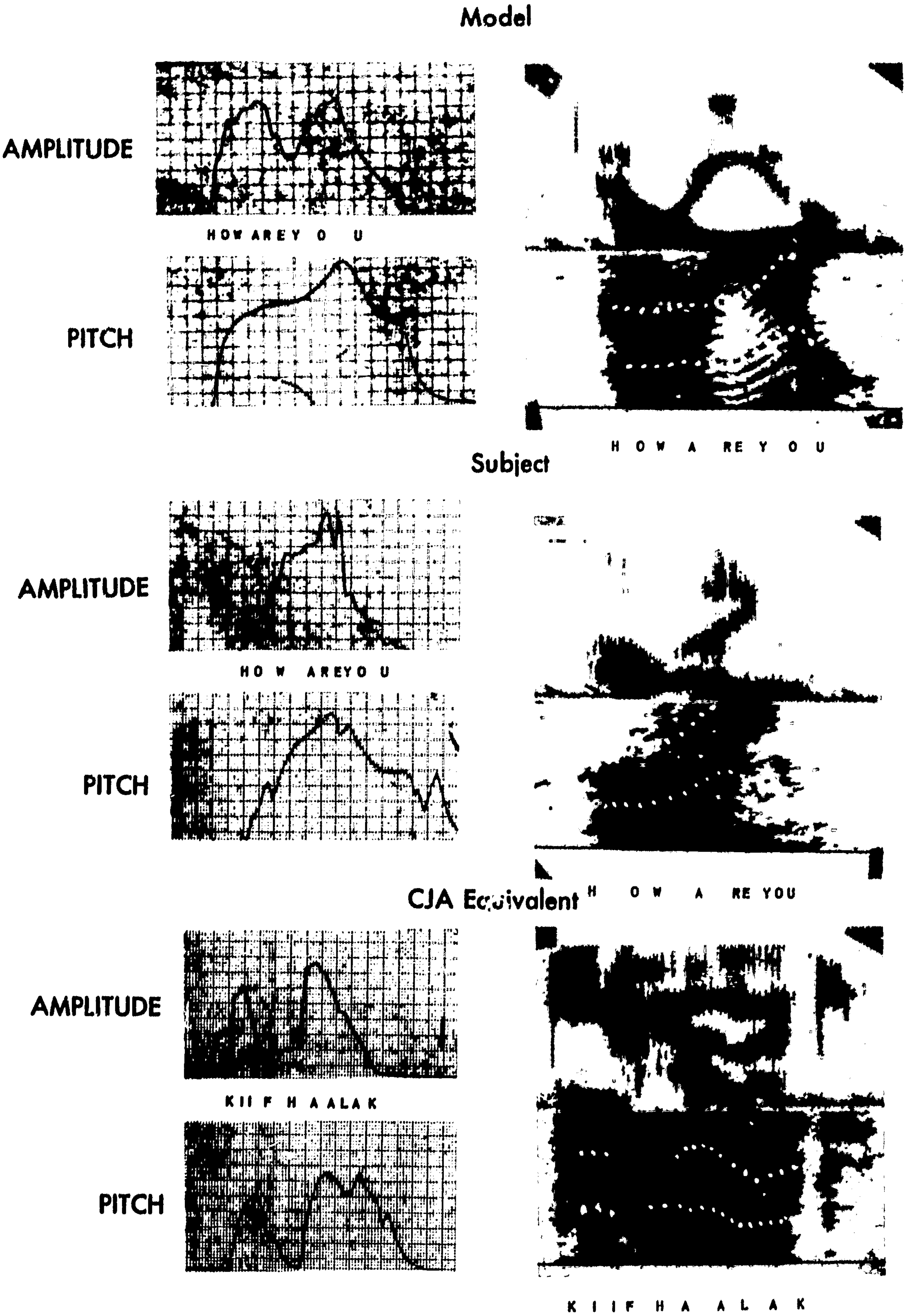

Fig. 14. An example of the S's attempt to produce the English greeting "How are you?" as a response.

1) a) How are you?
"2-3"2-3- /
(First of two speakers)

b) kiif ḥaa̤lak?
"2-3 "2-3- /

2) a) How are you?
"2-3"2-3- -3/
(Second speaker's response)

b) (winta) kiif ḥaa̤lak?
"2-3 '2-3"2-3- /

3) a) How are you?
3- "2-3- /
(Informal)

b) kiif ḥaa̤lak?
3- "2-3- /

2. Statements

Problems: Intonation patterns "2-4 final, "1-4 final, "3-2 final, "2-4-3 final.

Description of problems: The falling intonation contour "2-4 is the most frequent pattern in use in GAE at the end of matter-of-fact statements, signaling finality. In CJA, finality is expressed by the falling intonation "2-3. Observe the following:

1) a) English is a difficult language to learn.
3- "2-4//

b) (ʔi)lingliizi luɣa ṣaʕba nitʕallamha.
3- "2-3 "2-3- "2-3 //

2) a) He's been studying English for eleven years.
3- "2-4//

b) ṣaarlu byudrusi⌣ngliizi⌣ḥdaʕšar sana.
"2-3- "2-3- "2-3- "2-3- '2-3 //

3) a) I visited America in nineteen fifty-seven.
3- "2-4//

b) zurtʔameerka sant ʕalfu wtisiʕmiyya wsabʕa wxamsiin.
"2-3- "2-3- "2-3- "2-3- "2-3- -3//

In contrast-showing situations, GAE uses a number of intonation patterns which, accompanied by strong stress, indicate the center of attention that the speaker wants to emphasize. Following is a list of such contours which were found in the corpus.

Type	Position in pause group	Meaning
Falling contours		
"1-4	final	intense contrastive pointing
"1-3	non-final	less intense in contrast than 1-4, plus the meaning of non-finality
"2-4	final	mild contrast; finality
"2-3	non-final	moderate contrast; non-finality
Rising contours		
"3-2	final	contrastive pointing
Falling-rising		
"2-4-3	final	contrast plus surprised attention

In like manner, CJA signals contrast in statements by the use of the following intonations:

Type	Position in pause group	Meaning
Falling		
"1-3	non-final and final	intense contrast, unexpectedness plus surprised attention
"2-3	non-final and final	moderate mild contrast, non-finality and finality in final position

Examples:

1) a) English is a difficult language to learn.
   3- "1-4- -4//

   b) (mʔakkadi)~lingliizi luɣa saʕba nitʕallamha.
   3"1-3 "2-3 "2-3 "2-3- //

2) a) Fahd had lived a comfortable life, but his brother hadn't.
"1-3- -3/ "2-3- -4//

b) fahd ʕaaš ḥayaa~mliiḥa, bas ʔaxuu maa ʕaaš.
"1-3- "2-3- "3-3-/ 3- "2-3-"2-3 -3//

3) a) I'd like you to meet my roommate, Farid.
3- "2-4- -4//

b) baḥibb~aʕrfak ʕazamiil ya fariid.
3-"2-3- "2-3- "2-3- "2-3 //

4) a) I'd like you to meet my roommate,Farid.
3- "2- 4 "2-4//

b) baḥibb~aʕarfak ʕazamiili fariid.
3-"2-3- "2-3- "2-3 "2-3 //

5) a) He's been studying English for eleven years.
3- "2-4- -4//

b) ṣaarlu byudrusi~ngliizi~ḥdaʕšar sana.
"2-3- "2-3- "2-3- "2-3 '2-3 //

6) a) Fahd had lived a comfortable life, but his brother hadn't.
3- "2-4- -3 /3- "2-4- //

b) fahd ʕaaš ḥayaa~mliiḥa, bas ʔaxuu maa ʕaaš.
"3- -3-"2-2 '3-3/ 3- "2-3 "2-3 -3//

7) a) It's about twenty-eight miles.
3- "2-4- -4//

b) tagriiban θamaanya wʕišriin miil.
3- 2-3- "2-3- "2-3 '2-3 //

8) a) English is a difficult language to learn.
"2-3- -4//

b) (ʔi)lingliizi luɣa saʕba nitʕallamha.
3- "2-3- "2-3- "2-3 //

9) a) He's been studying English for eleven years.
3- "2-3- -4//

b) ṣaarlu byudrusi~ngliizi ḥdaʕšar sana.
"2 -3- "2-3- "2-3- "2-3- '2-3 //

10) a) English is a difficult language to learn.
3- "3-2 -4//

b) (ʔi)lingliizi luɣa ṣaʕba nitʕallamha.
3- "2-3- "2-3- "2-3- //

11) a) English is a difficult language to learn.
3- "2-4-3//

b) (ʔi)lingliizi luγa ṣaʕba nitʕallamha.
3- "2-3- "2-3- "1-3-↗ //

Interpretation of errors: GAE "2-4 intonation pattern signaling the meaning of finality gave trouble to the Jordanian Ss. Following the CJA intonation pattern used for such a situation, the Ss substituted their "2-3 intonation pattern instead. The difference resulting from changing the GAE "2-4 intonation to the "2-3 intonation made the Ss fail to produce the proper GAE contour on the last word, and at the same time gave the impression that the Ss had not finished speaking. Note the production of the following statements by the Ss:

1) a) English is a difficult language to learn.
"2-3- "2-3- "2-3- "2-3//
(English not Arabic)

(ʔi)lingliizi luγa saʕba nitʕallamha.
3- "2-3- "2-3- "2-3 //

2) a) He has been studying English for eleven years.
3- "2-3- "2-3- "2-3- "2-3- "2-3 //
(Emphasis on number of years)

ṣaarlu byudrusi~ngliizi~ḥdaʕsar sana.
"2-. 3- "2-3- "2-3- "2-3 '2-3- //

3) a) I visited America in nineteen fifty-seven.
3"2-3- "2-3- "2-3-"2-3- -3//
(Matter-of-fact statement)

zurt ʔameerka sant ʔalfu wtisiʕmiyya wsabʕa wxamsiin.
"2-3- "2-3- "2-3- "2-3 "2-3 -3//

As we have seen, intense contrastive pointing in statements is expressed in GAE by the falling primary contour "1-4 which implies emphasis and intensity carried by pitch /1/. Less intense contrasts are conveyed by the falling contour "1-3. Both meanings are expressed by the falling contour "1-3 in CJA.

It is worth mentioning here that the intonation pattern of intense contrast "1-4 that falls on the verb is, in the example given below, was not noticed by any of the Ss. The comparable contrastive situation in CJA is indicated by the addition of the emphatic word m?akkad. The verb to be is not as significant in CJA as it is in GAE, especially in its present tense form. Here are some examples:

1) a) English is a difficult language to learn.
"2-3- "2-3- "2-3- "2-3 //
(The fact that English is difficult)

(m?akkadi)~lingliizi luɣa saʕba nitʕallamha.
3-"1-3- "2-3- "2-3- "2-3- //

2) a) Fahd had lived a comfortable life, but his brother hadn't.
"1-3- "2-3- "2-3- "2 -3/ 3- "2-3- "2-3 //
(Fahd in contrast with his brother)

fahd ʕaaš ḥayaa~mliiḥa, bas ?axuu maa ʕaaš.
"1-3 "2-3- "3-3-/ 3- "2-3-"2-3 -3//

The most frequent contour in GAE used to indicate contrasts in statements is the falling contour "2-4. Equivalent meaning in CJA is conveyed by the primary contour "2-3 or its extended form "2--3. Observe how the Ss produced the "2-3 intonation pattern with disconcerting frequency in the course of the same utterance. (See Figs. 15 and 16)

Examples:

1) a) I'd like you to meet my roommate, Farid.
3- "2-3- "2-3- "2--3 "2-3 //
(Introduces his friend to Farid)

baḥibb~aʕarfak ʕazamiili ya fariid.
3-2-3- "2-3- "2-3 "2-3 //

2) a) I'd like you to meet my roommate, Farid.
3- "2-3- "2-3- "2- -3 "2-3 //
(Introduces his friend, Farid)

baḥibb~aʕarfak ʕazamiili fariid.
3-2-3- "2-3- '2-3- "2-3 //

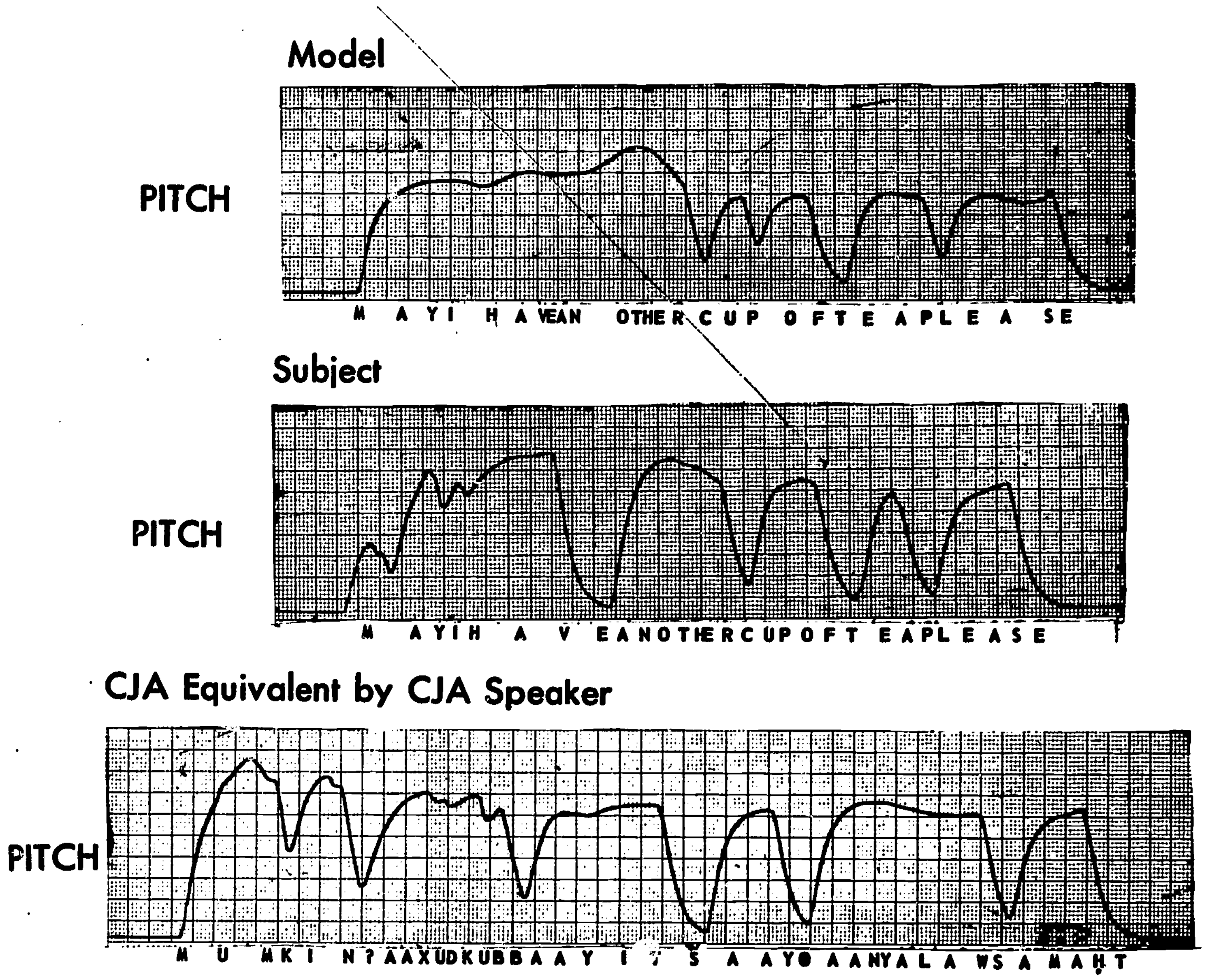

Fig. 15. Graph showing excessive number of pitch contours in the course of a single English utterance as attempted by the S.

MODEL

	May	I	have	another	cup	of	tea	please
Frequencies:	165	168	180	210	145	148	150	150

SUB

	May	I	have	another	cup	of	tea	please
Frequencies:	205	196	217	214	195	200	180	195

CJA

	Mumkin	ʔaaxud	kubbaayit	šaay	θaanya-law	samaht
Frequencies:	228	218	208	194	200	195

Fig. 16. Data based on Fig. 15 showing pitch relative to highest value for M and S.

3) a) He has been studying English for eleven years.
3-"2-3- "2-3- "2-3- "2-3- "2-3 //
(Emphasis on number of years)

ṣaarḷu byudrusi~ngliizi~ḥdaˤšar sana.
'2-3- "2-3- '2-3- "2-3 '2-3-//

4) a) Fahd had lived a comfortable life, but his brother hadn't.
"2-3 "2-3- "2-3- "3-3/ 3- "2-3 "2-3 //
(Emphasis on had and hadn't)

fahd ˤaaš hayaa~mliiḥa, bas ʔaxuu maa ˤaaš.
"2-3-"2-2 "3-3 / 3- '2-3-"2-3 -3//

There is an important difference between GAE and CJA in their use of contrastive-pointing intonations in utterances where the center of attention is focused on verb phrases or numerals containing two figures. In GAE, the center of the contrastive intonation pattern "2-4, for example, falls on the auxiliary verb in a verb phrase such as had lived, and on the second digit of the numeral twenty-eight. In CJA, two-word verb phrases of the type had lived implying the meaning of past perfect tense do not exist. Thus, the equivalent finite verb 'lived' carries the center of the contrastive intonation pattern "2-3. This is illustrated in Fig. 17 and the following example:

Fahd had lived a comfortable life, but his brother hadn't.
"2-3- "2-3- "2-3- '3-3 /3- "2-3- "2-3 //

fahd ˤaaš hayaa~mliiḥa, bas ʔaxuu maa ˤaaš.
"2-3 "2-3 "3-3 / 3- "2-3 "2-3 -3//

As for numerals consisting of two digits in CJA, the first digit of the two is made the center of the contrastive intonation pattern "2-3 indicating a contrastive situation. Note the following sample which is verified in Fig. 18.

It's about twenty-eight miles.
3- "2-3- "2-3- "2-3- '2-3 //

tagriiban θamaanya wʕišriin miil.
3- "2-3- "2-3- "2-3 '2-3 //

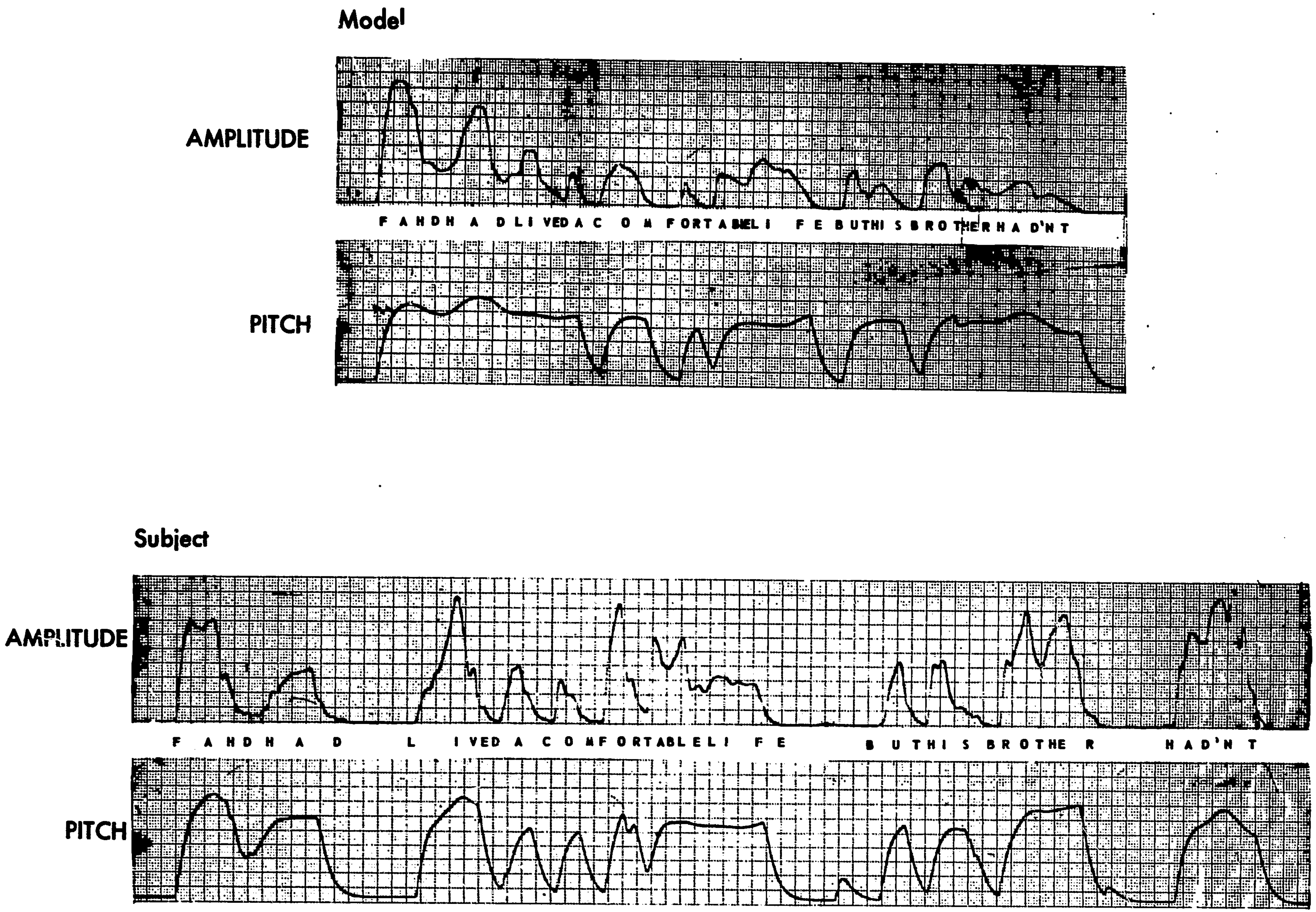

Fig. 17. An illustration of incorrect emphasis on lived rather than on the auxiliary verb had.

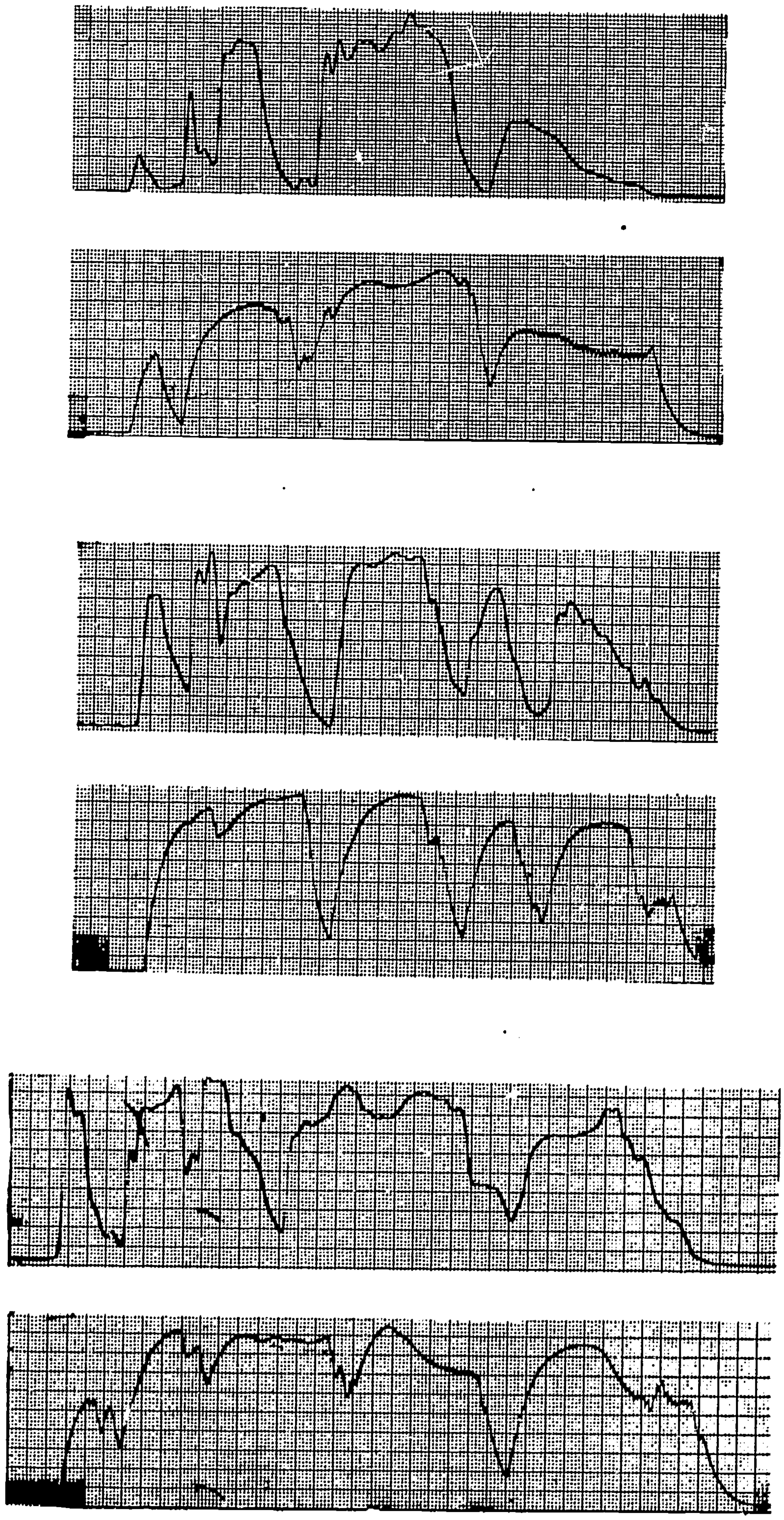

Fig. 18. S's emphasis on the first rather than the second digit of a two-digit number.

The Ss had no trouble producing the contrastive pointing intonation "2-3, but they often produced it with great frequency within the same utterance as in CJA.

In GAE, contrasts in statements are sometimes carried by the rising "3-2 intonation pattern. This intonation was a source of trouble to the Ss, who tended to change it for their regular contrastive intonation pattern "2-3.

Example:

```
  English is a difficult language to learn.
"2-3-          "2-3-     "2-3-        "2-3  //
  (Difficult not easy)

  (ʔi)lingliizi luɣa ṣaʕba nitʕallamha.
   3-     "2-3-          "2-3-        "2-3-  //
```

GAE also uses the falling-rising intonation "2-4-3 for contrast plus surprised attention in statements, whereas CJA has very few falling-rising patterns in its intonation system. That is why all the Ss produced the GAE intonation "2-4-3 incorrectly, replacing it with their common contrastive intonation "2-3. The meaning of surprised attention is provided for in the CJA "2-3 pattern by giving the syllable lam, which receives the center of the intonation pattern higher pitch, a little greater stress and longer duration than normal.

Example:

```
  English is a difficult language to learn!
"2-3-          "2-3-     "2-3-          "2-3↗/
  (Repeated with surprise)

  (ʔi)lingliizi luɣa ṣaʕba nitʕallamha!
   3-     "2-3-          "2-3          "1-3-↗ /
```

3. Yes-no questions

Problems: Intonation patterns "2-4 non-final and final, "3-2 non-final, "4-2 non-final, "2-4-3 non-final, "3-2-3 non-final.

<u>Description of problems</u>: The primary falling intonation "2-4 signals contrastive pointing in yes-no questions in non-final and final positions. Similarly, contrasts are expressed by the "2-3 intonation pattern in non-final position.

To indicate contrast plus surprised deliberation, the primary rising intonation "3-2 is used accompanied by a rise in pitch at the end of the utterance. The rising intonation "4-2 is also used for contrasts, preceded by a fall in pitch in the middle of the utterance.

GAE uses the falling-rising "2-4-3 as well as the rising-falling "3-2-3 for incomplete contrastive pointing. The meaning conveyed by these two contours has a touch of unexpectedness.

There is some correspondence between CJA and GAE in the use of the intonation pattern "2-3 for contrast; but instead of the fall in pitch at the end of the question in GAE, there is a rise in pitch in CJA. The primary contour "3-2 is also used in final position in CJA to indicate contrast. There are some cases in CJA where yes-no questions use the level contour "2-2 or its extended form "2--2 for moderate contrastive pointing plus strong implications of expectedness. Notice the following illustrations:

1) a) Didn't the mailman deliver the letter yesterday?
3- "2-4 /

b) majabši~boosṭaji~lmaktuubi~mbaarih?
3-"2-3- "2-3- "2-3- "3-2 /

2) a) Do you really like to eat Arab food?
3- "2-4- -4/

b) saḥiiḥ bitḥib tuukil ʕakil ʕarabi?
3- "2- -2/

3) a) Will you be here next semester?
3- "2-3- -4/

b) raayḥi~tkuun hooni~lfaṣli~jjaay?
3- "1-3- '3-2 /

4) a) Will you be here next semester?
3- "4-2- -2/

b) raayḥi~tkuun hooni~lfasli~jjaay?
3- "2-3- "3 -2/

5) a) Didn't the mailman deliver the letter yesterday?
"3-2- -2/

b) majabši~lboosṭaji~lmaktuubi~mbaariḥ?
3-"2-3 "2-3- "2-3 "3 -2/

6) a) Do you really like to eat Arab food?
3- "2-4-3- -4/

b) saḥiiḥ bitḥibb tuukil ʔakil ʕarabi?
3- "2-3- "3-2/

7) a) Do you really like to eat Arab food?
3- "3-2-3- -4/

b) ṣaḥiiḥ bitḥibb tuukil ʔakil ʕarabi?
3-"2- -2/

Interpretation of errors: It was difficult for the Ss to produce the "2-4 intonation pattern. They replaced it by their own intonation patterns "3-2 and "2--2, giving a rise in pitch at the end of all questions.

Examples:

1) a) Didn't the mailman deliver the letter yesterday?
3"2-3 "2- -2 "2-3- "2-3- "3- -2 /
(Not the day before)

majabši~lboosṭaji~lmaktuubi~mbaariḥ?
3-"2-3- "2-3- "2-3- "3- -2 /

2) a) Do you really like to eat Arab food?
3- "2-3- "2-3- "3-2/
(Emphasis on eat)

ṣaḥiiḥ bitḥibbtuukil ʔakil ʕarabi?
3-"2-3- "2-3- "3- 2/

There are no problems involved in the production of the contrastive pointing intonation "2-3, except for one thing--the Ss raised their pitch at the end of the questions including this contour, instead of letting their pitch fall as in the case of native speakers of GAE.

Example:

Will you be here next semester?
"3-3 "1-3- "3-2 /
(Here in contrast with another place)

raayḥi tkuun hooni~lfaṣli~jjaay?
"3- -3- "1-3- '3-2 /

The GAE primary contour "4-2 has no place in the intonational system of CJA. Thus, the Ss produced this intonation after their comparable intonation pattern "2-3.

Example:

Will you be here next semester?
"3-3- "2-3- "3-2/
(Next semester in contrast with this semester)

raayḥi~tkuun hooni~lfaṣli~jjaay?
"3-3- "2-3- "3-2 /

The rising "3-2 intonation which carries the meaning of contrast plus surprised attention was replaced by the parallel CJA pattern "2-3, which is different in form and position. Observe the following:

Didn't the mailman deliver the letter yesterday?!
3"2-3- "2-- 2 "2-3- "2-3 "3- 2 /
(With surprise)

majabši~lboosṭaji~lmaktuubi~mbaariḥ?
3-"2-3- "2-3- "2-3- 3- -2 /

The falling-rising "2-4-3 and the rising-falling "3-2-3 contours were a problem to the Jordanian Ss because CJA has these only rarely. The Ss used the "2-3 intonation in the first case and the extended level contour "2--2 which stretches over the whole question in the second case. This made the Ss sound as if they were a little angry when they did not mean to be. Here are some examples, the second of which is shown graphically in Figs. 19 and 20.

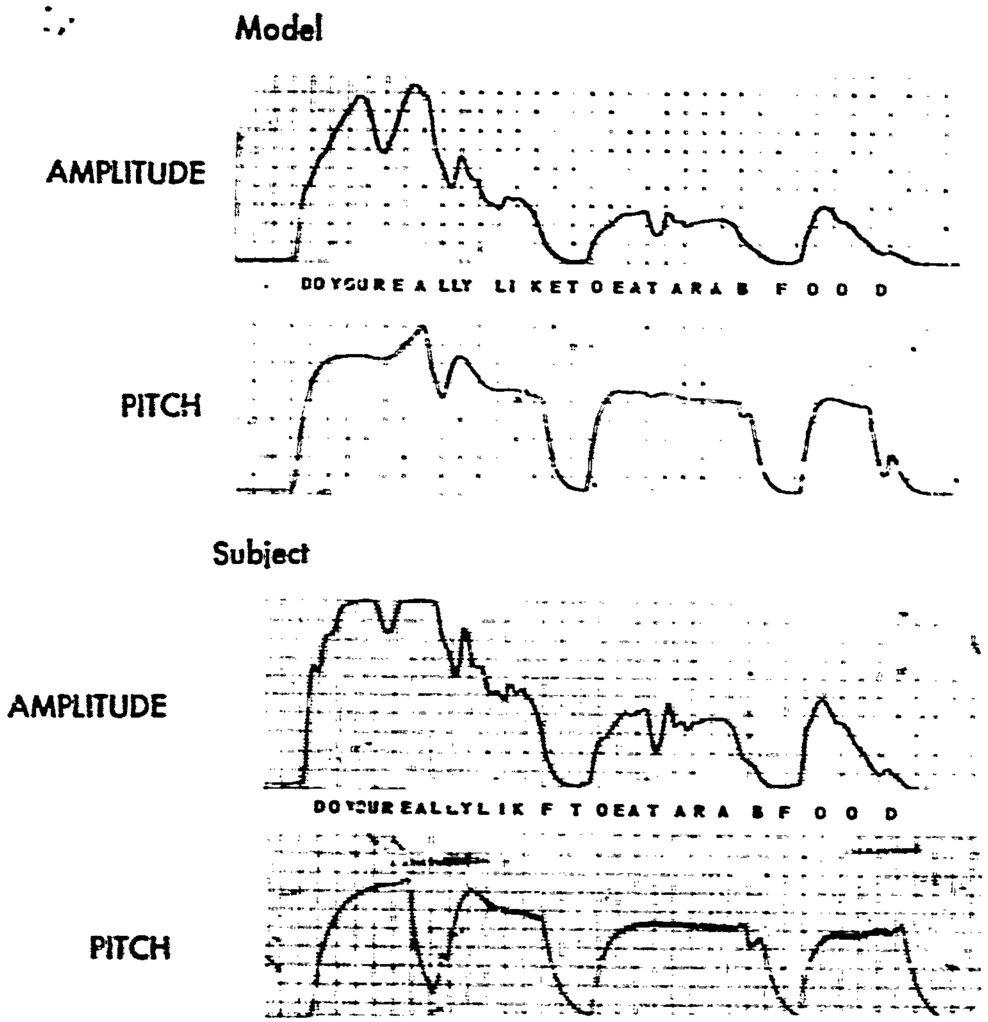

Fig. 19. Strip charts showing difference with respect to changes in pitch between M and S in producing the GAE rising-falling intonation "3-2-3.

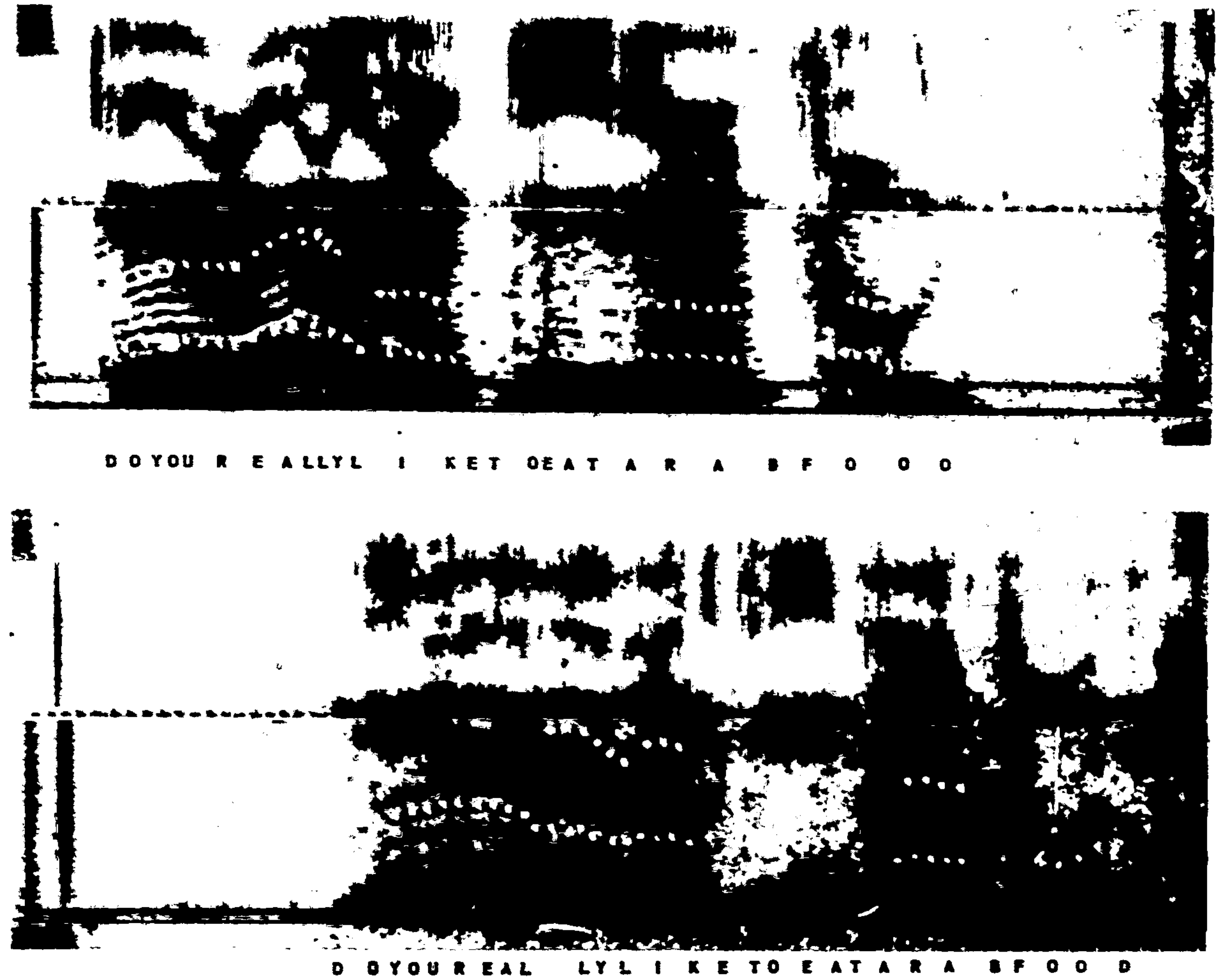

Fig. 20. Spectrograms showing difference with respect to changes in pitch between M and S in producing the GAE rising-falling intonation "3-2-3.

1) a) Do you really like to eat Arab food?
3- "2-3- "2-3- "2-3- "3-2/
(Emphasis on like)

b) ṣaḥiiḥ bitḥibb tuukil ʔakil ʕarabi?
3- "2-3- "2-3 "2-3 "3 -2/

2) a) Do you really like to eat Arab food?
3- "2- -2/
(Is it true?)

b) ṣaḥiiḥ bitḥibb tuukil ʔakil ʕarabi?
3-2- - 2/

4. Wh-questions

Problems: Intonation patterns "2-4 final, "2-1 final, "1-4-3 non-final and final.

Description of problems: GAE uses the falling primary intonation "2-4 at the end of the utterance to indicate wh-questions.

Examples:

1) a) How do you like living in America?
3- "2-4- //

b) kiif bitšuufi~lʕiiša bʔameerka?
"2-3- "3-3↗ /

2) a) What's his brother's name?
3- "2-4//

b) (ʔi)ššuu ʔisim ʔaxuu?
3- "2-3-'2-3- "3-3↗/

In GAE, interrogative pronouns sometimes become the center of attention under special contrasting situations. In a mild contrastive situation, the "2-4 final or "2-3 non-final primary intonation is used; whereas in a situation where contrastive pointing and unexpectedness are implied, the rising primary contour "3-2 final is used.

Echo questions are signaled by the rising intonation pattern "2-1 which marks the end of the question, adding the meaning of unexpectedness. In the case where incomplete deliberation plus surprised attention are indicated, GAE uses the falling-rising pattern "1-4-3 in pause group final position.

In CJA the common intonation pattern "2-3 is used to signify mild contrasts in this type of question. There is always a tendency towards rise in pitch on interrogative words, even when the center of attention is shifted to other words in the utterance.

Unlike GAE which gives pronouns in contrasting situations their due importance in terms of stress and pitch, CJA according to its structure adds to the original utterance the pronoun meant for contrast. In cases where the pronoun is repeated after a pronoun suffix on a noun, the noun to which the pronoun is suffixed receives emphasis.

Both GAE and CJA use the "3-2 intonation in non-final position, for contrast-pointing situations, where expectedness and intensity are implied. The same intonation is used in CJA at the end of questions to signal echo questions. To indicate a question repeated with surprised deliberation, CJA uses the rising-falling-rising intonation "3-1-3.

Examples:

1) a) What would you like to eat, sir?
"2-4 -3 / -4/.

b) (ʔi)ššuu bitḥibb tuukil ya sayyid?
3- "2-3 "2-3- "3-2 /.

2) a) How do you like living in America?
3- "2-4- -4/

b) kiif bitšuufi~lʕiišab ʔameerka?
3- "2-3- "3-3 ↗. /

3) a) How do you like living in America?
3- "2-4- -4/.

b) kiif (ʔinta) bitšuufi~lʕiiša bʔameerka?
3- "2-3- "2-3- "2-3-↗ /

4) a) Where did you put your registration materials?
3- "2-4- -4/

b) ween ḫaṭeeti~wraag tasjiilak?
"2-3- "2-3-↗ //

5) a) How did you come to America?
"2-3- -4/.

b) kiif~ijiit ʕaʔameerka?
"2-3- "2-3- ↗ /

6) a) What's his brother's name?
3- "2-1/

b) (ʔi)ššuu ʔisim ʔaxuu?
3- "2-3- "3-2 /.

7) a) Where did you say he put them?
"3-2- -2/

b) ween gult ḫaṭhum?
"3-2- -2 /

8) a) What's his brother's name?
3- "1-4-3/

b) (ʔi)ššuu ʔisim ʔaxuu?
3- "2-3 "2-3- "3-1-3↗ /

<u>Interpretation of errors:</u> The difference in the distribution and form of intonation patterns in wh-questions in GAE and CJA is responsible for the difficulty met by the <u>S</u>s in producing the "2-4 intonation pattern correctly. Transferring the comparable pattern of their native language, the <u>S</u>s tended to raise their pitch on interrogative words, replacing the GAE "2-4 intonation that usually comes at the end of a wh-question, with their "2-3 primary intonation, and then moving its center to the interrogative word at the beginning of the question. The following examples are given for illustration:

1) a) How do you like living in America?
"2-3- "2-3- "2-3-↗ /
(Living in contrast with visiting)

b) kiif bitšuufi~lʕiiša bʔameerka?
"2-3- "2-3- "3-3↗ /

2) a) What's his brother's name? (See Fig. 21)
"2-3- '2-3- "3-3↗/
(Normal question)

b) (ʔi)šsuu ʔisim ʔaxuu?
3- "2-3 '2-3 "3-3↗/.

3) a) What would you like to eat, sir?
"2-3- "2-3/ 3-2/.
(Giving choice)

b) (ʔi)šsuu bitḥibb tuukil ya sayyid?
3- "2-3 "2-3- "3-2 /

One more significant point to be added here is the slight rise at the end of questions in CJA. This influenced the Ss to rise a little bit at the end when they pronounced GAE utterances including questions, as seen in the examples above.

The Ss had no trouble with the "2-4 intonation falling on interrogative words or any other word in the question except for the fact that they pronounced it with the higher pitch level /3/ instead of the pitch level /4/, influenced by their language pattern "2-3. It is very important to repeat here what was said earlier, that no matter where the intonation center is focused, the Ss still raised their pitch on interrogative words. Notice the following:

1) a) What would you like to eat, sir?
"2-3- "2-3 "3-2/
(Giving choice)

b) (ʔi)šsuu bitḥibb tuukil ya sayyid?
3- "2-3- "2-3- "3-2/

2) a) How do you like living in America?
"2-3- "2-3- "3-3- /
(Living in contrast with visiting)

b) kiif bitšuufi~lʕiiša bʔameerka?
"2-3- "2-3- "2-3-↗/

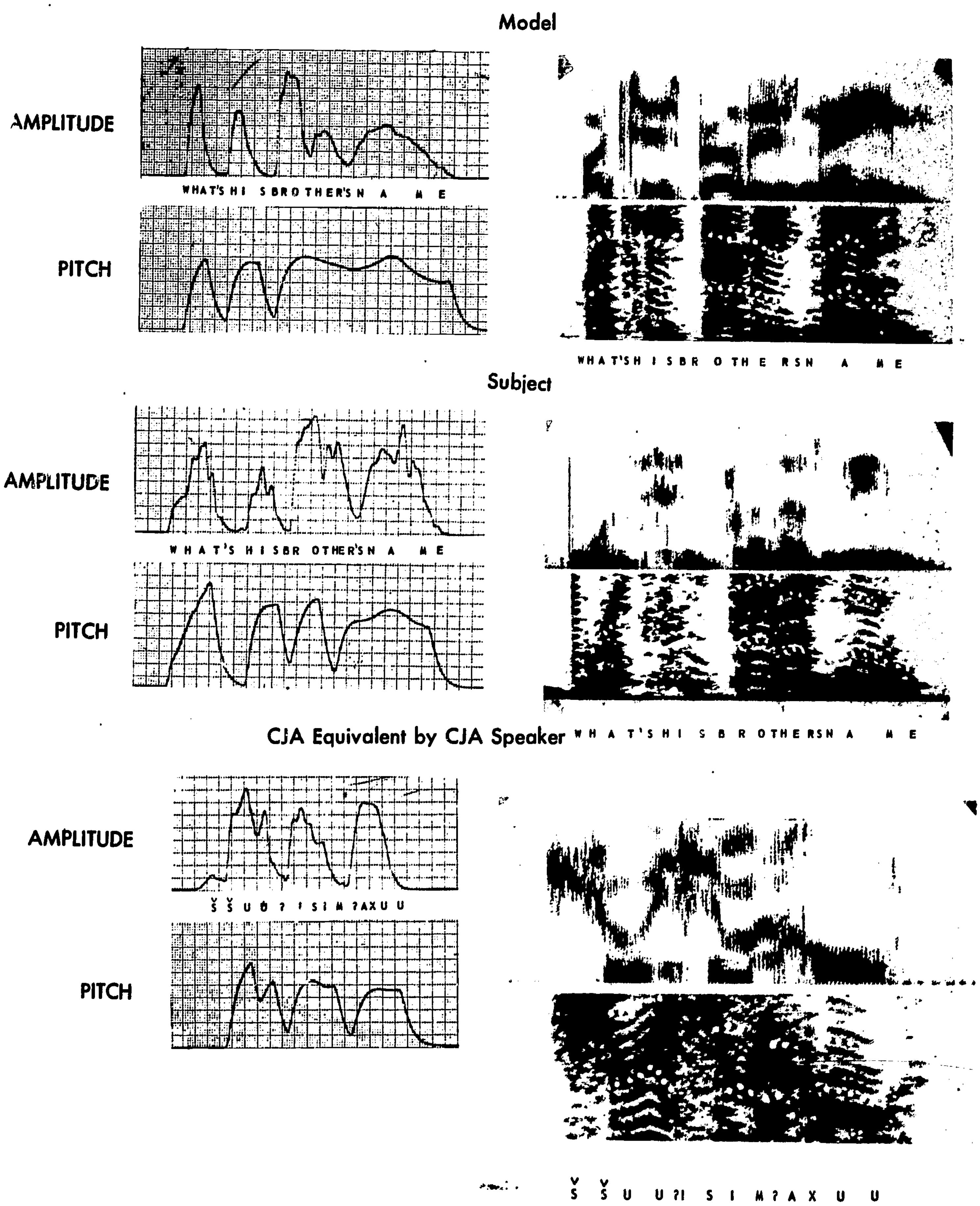

Fig. 21. Both strip charts and spectrograms showing S's tendency to rise on the interrogative word instead of the last word in the English question.

3) a) How do you like living in America?
"2- "2- 3-↗/
(<u>you</u> contrasted with <u>he</u>)

b) kiif bitšuufi~lˤiiša bʔameerka?
"2-3- "2-3-↗/

c) kiif (ʔinta) bitšuufi~lˤiiša bʔameerka?
'2-3 "1-3- "2-3-↗/.

In contrastive situations, where the separate or suffixed pronouns receive the center of attention, the <u>Ss</u> pronounced these pronouns as usual without any rise in pitch to indicate contrast. The grammatical differences between CJA and GAE patterns are responsible for the errors of the <u>Ss</u> since in CJA the structures of contrastive situations are not treated the same as in GAE. To contrast subject pronouns such as <u>you</u> with <u>I</u> or <u>he</u>, CJA adds a pronoun to the question.[10] GAE points the contrast of possessive pronouns by merely making the possessive pronoun the center of attention by means of stress and intonation. CJA, on the other hand, puts a rise in pitch and stress on the syllable of the noun next to the suffixed pronoun. This habit influenced the <u>Ss</u> to give special stress and a rise in pitch to the GAE word <u>materials</u>, as seen in the following example and in Fig. 22.

a) Where did you put your registration materials?
"2-3- "1-3↗/

b) ween ḥaṭeeti~wraag tasjiilak?
"2-3- "1-3-↗/.

All the <u>Ss</u> produced the GAE intonation pattern "2-3 falling on interrogative words correctly, since this intonation corresponds with the CJA pattern in meaning, form, and position.

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[10]See example number (3-c) above.

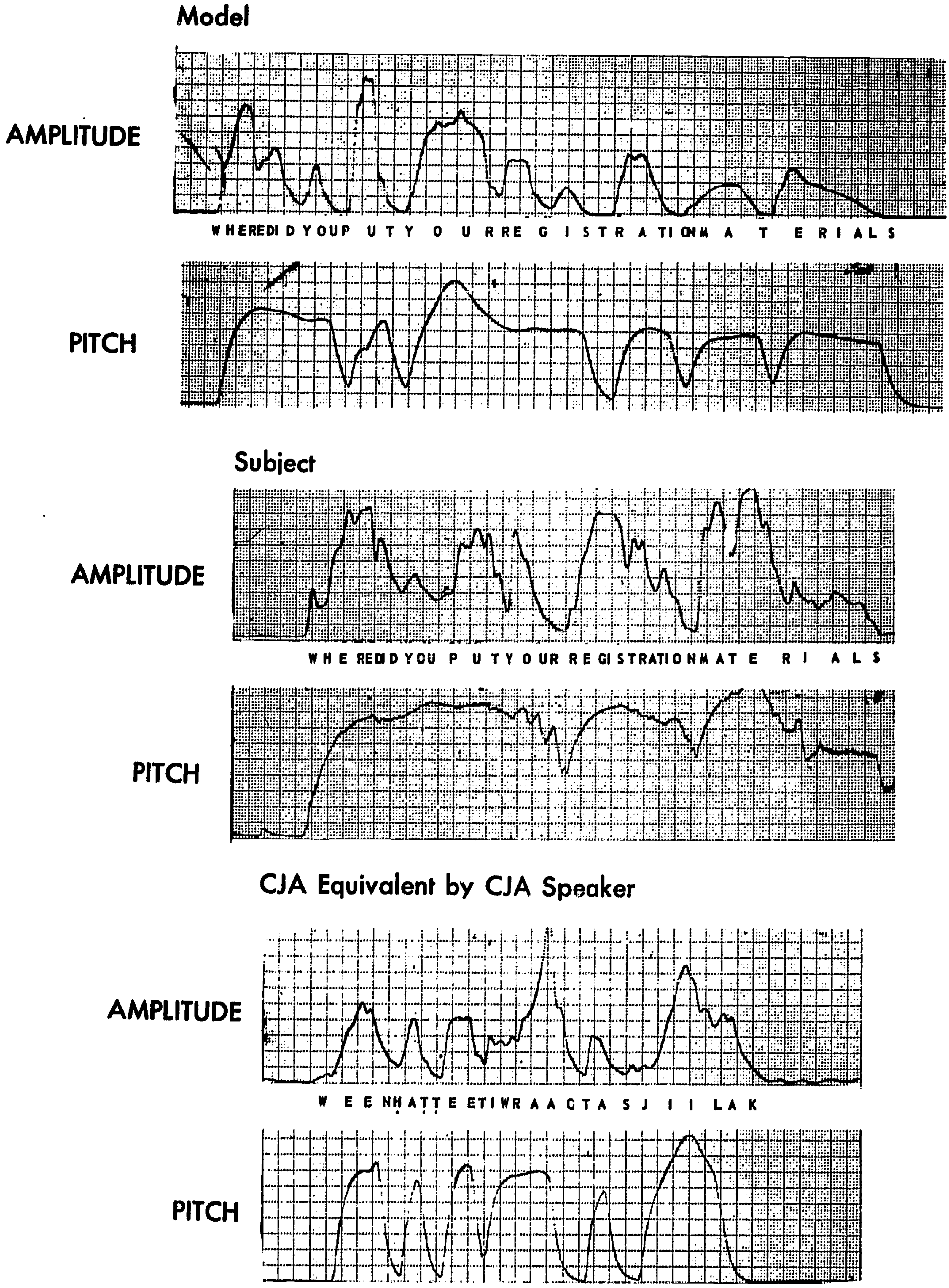

Fig. 22. An illustration of the difference between GAE and CJA intonational patterns in pointing the contrast of possessive pronouns.

Example:

a) How did you come to America?
"2-3- 2-3-↗/

b) kiifi~ijiit ʕaʔameerka?
"2-3- "2-3-↗/.

As for the "2-1 intonation that signals echo questions in English, the Ss pronounced it at a lower pitch using the "3-2 intonation instead, influenced by the CJA intonation pattern "3-2 that marks the end of echo questions.

Examples:

a) What's his brother's name?
"2-3- "2-3- "3-2//

b) (ʔi)ššuu ʔisim ʔaxuu?
3- "2-3 "2-3 "3-2 //

The similarities between the "3-2 primary contours in the two languages made it easy for the Ss to produce this intonation correctly, as in:

a) Where did you say he put them?
"3-2- -2/.
(With surprise and astonishment)

b) ween gult ḥathum?
"3-2- -2/

None of the Ss correctly pronounced the "1-4-3 intonation that marks the end of a question that is repeated with surprise. Two of them tended to use the rising contour "3-2, with a little greater stress than usual, in its place, and the others used the comparable CJA pattern "3-1-3↗ instead:

a) What's his brother's name?
"2-3- "2-3- "3-2/

b) (ʔi)ššuu ʔisim ʔaxuu?
3- "2-3- "2-3-' "2-3 /.

c) (ʔi)ššuu ʔisim ʔaxuu?
"2-3- "2-3- "3-1-3-↗/

5. Requests and Commands

Problems: Intonation patterns "2-4 final "3-2 non-final, "3-2-3 final.

Description of problems: Both the falling "2-4 and the rising "3-2 intonations are used for contrastive pointing in requests and commands. In like manner, the rising-falling "3-2-3 intonation is used for contrast, expressing annoyance on the part of the speaker.

Conversely, all contrast-showing situations in commands and requests are signaled by the falling patterns "2-3 and "1-3 in CJA. When the situation calls for annoyance or irritation, the primary contour "1-3 is used. Observe the following:

1) a) Tell me what you're going to do after the exam.
3- "2-4- -4//

b) gulli~~ššuu biddak tiˁmal baˁdi limtiḥaan.
"2-3- "2-3- "2-3- -3 //

2) a) Tell me what you're going to do.
"2-4- -4//

b) gulli~~ššuu biddak tiˁmal.
"2-3- '2-3- "2-3 //

3) a) Wait a minute.
"2-4- -4//

b) ʔistanna dagiiga.
3- "2-3 "3-3 //

4) a) Wait a minute.
"3-2-3- -4//

b) ʔistanna dagiiga.
3- "1-3- "3-3 //

5) a) May I have another cup of tea, please.
3- "2-4/ -4//

b) mumkin ʔaaxuð kubbaayit šaay θaanya law samaḥt.
3- "2-3 "2-3- "2-3- "2-3- "2-3- "3-2 /

6) a) May I have another cup of tea, please.
3- "3-2- / "3-3 //

b) mumkin ʔaaxuð kubbaayit šaay θaanya law samaḥt.
"2-3- '2-3- "2-3- "2-3 "2-3- "3-2 //

<u>Interpretation of errors</u>: The <u>Ss</u> had the same trouble in producing the "2-4 intonation here as elsewhere. All of them replaced it by the "2-3 intonation which CJA employs in such situations. Note the following:

1) a) Tell me what you're going to do after the exam.
"2-3- "2-3 "2-3"2-3- -3//
(Tell me about the activity you're going to perform)

b) gulli~~ššuu biddak tiʕmal baʕdi~limtiḥaan.
"2-3- "2-3- '2-3- -3 //

2) a) Tell me what you're going to do.
"1-3- "2-3- 2-3//
(Inform me . . .)

b) gulli~~ššuu biddak tiʕmal.
"1-3- "2-3- "2-3 //

3) a) Wait a minute.
"2-3- "3 -3//
(Normal request)

b) ʔistanna dagiiga.
3- "2-3- "3 -3//

4) a) May I have another cup of tea, please.
"2-3- "2-3-"2-3 "2-3- "2-3 "3-2/
(Tea not coffee)

b) mumkin ʔaaxuð kubbaayit šaay θaanya law samaḥt.
"2-3- "2-3- "2-3- "2-3 "2-3- "3-2 /

GAE uses the "3-2 intonation for contrast in requests and commands, whereas CJA tends to use the common intonation "2-3 instead. The <u>Ss</u> substituted their intonation pattern "2-3 for the GAE "3-2 intonation, as illustrated in the following example:

a) May I have another cup of tea, please.
"2-3 "2-3-"2-3 "2-3 "2-3 "3-2/
(Asking for a second cup of tea)

b) mumkin ʔaaxuð kubbaayit šaay θaanya law samaḥt.
"2-3- "2-3- "2-3 "2-3 "2-3- "3-2 /

CJA uses the intonation pattern "1-3 to express annoyance and impatience. The Ss replaced the GAE intonation "3-2-3 by their own intonation "1-3, producing it with the same intensity of "2-3. This made them sound overemphatic and abrupt to GAE native speakers. Fig. 1 shows this clearly. Here is a sample for illustration:

a) Wait a minute.
   "1-3- "3 -3//
   (Spoken with annoyance)

b) ʔistanna dagiiga
   3-"1-3 3-3 //

6. Exclamatory Sentences

Problems: Intonation patterns "4-3 non-final, "4-2 non-final, "4-1 non-final, "3-2-4 final.

Description of problems: The primary rising intonation "4-3 is employed in GAE in non-final position, to give the meaning of incomplete deliberation plus expectedness. The same meaning is signaled by the rising intonation pattern "4-2, but in a stronger manner. In order to express an extreme degree of incomplete deliberation and unexpectedness plus surprise, the rising "4-1 intonation is used. The corpus contains only one primary contour of the rising-falling type "3-2-4 which occurs in pause group final position, signaling contrastive pointing and surprise.

Exclamation, unexpectedness and surprise are generally indicated by rising contours in CJA, but the contours used are of higher pitch than those in GAE. For example, the intonation "1-3 occurs initially implying incompleteness plus unexpectedness; "3-1 in initial position also indicates disbelief mixed with surprise; "2-2 functions in initial position to give the meaning of incompleteness and unexpectedness; and the rising intonation pattern "2-1 is used to signal extreme surprise and unexpectedness.

Examples:

1) a) What! Mahdi! I can't believe that!
"4-2 / "4-1 / 3- "3-2-3//

b) ʔeeš! mahdi! ʔanaa maa baṣaddig haššii?.
"1-3↗/ "2-1 / "2-3 "2-3 "2- 3//

2) a) What, Mahdi! I can't believe that!
"4-3 /"2- 1 / "3-2-3 -4//

b) ʔeeš ya mahdi! ʔanaa maa baṣaddig haššii?
"2-2 "3-2/ 3- "2-3- "2-3 '2-3 //

<u>Interpretation of errors</u>: The rising intonation "4-2 that falls on the interrogative word <u>what</u> is replaced by the "1-3 intonation pattern which CJA uses in this situation. The GAE intonation "4-1 is changed to the CJA "2-1 intonation. CJA speakers using the "2-1 intonations in GAE express stronger emotional feeling in this situation than native speakers of GAE.

In like manner, the GAE intonation pattern "4-3 which falls on the interrogative word in the situation where Mahdi is addressed, is changed to the CJA level intonation contour "2-2, which also sounds more emotional and stronger than the GAE "4-3 intonation for the same reason mentioned above.

As in the case of most rising-falling and falling-rising intonations, the <u>S</u>s had difficulty in producing the "3-2-4 primary intonation contour. They replaced it with their falling intonation pattern, "2-3.

As for the GAE intonation pattern "3-1, it was produced correctly by all the <u>S</u>s since it corresponds with the comparable intonation in CJA in form and meaning. Compare the following:

1) a) What! Mahdi! I can't believe that.
"1-3 /, "2-1 //3"2-3- "2-3- "2-3//
(Speaking about Mahdi)

b) ʔeeš! mahdi! ʔannaa maa baṣaddig haššii
"1-3↗/ "2-1 /, 3- "2-3 '2-3- "2-3 //

2) a) What, Mahdi! I can't believe that!
"2-2 /"3--2 / 3-"2-3- "2-3- "2-3 //
(Speaking to Mahdi)

b) ʔeeš ya mahdi! ʔanaa maa baṣaddig aaššii?
"2 - 2 "3- 2/ 3- "2-3- "2-3- "2-3 //

7. Attached Questions

Problems: Intonation patterns "2-4 final, "4-2 final.

Description of problems: GAE uses the falling intonation "2-4 for attached questions expecting confirmation, and the rising intonation "4-2 for attached questions asking for information.

On the other hand, CJA uses the rising intonation "3-2 in the first case and the higher rising intonation "3-1 in the second.

Examples:

1) a) Doesn't he?
"2- -4/

b) mišheek?
3-"3- 2/

2) a) Doesn't he?
"4- -2

b) mišheek?
3-"3-1 /

Interpretation of errors: The four Ss transferred their rising intonations "3-2 and "3-1 when they produced GAE utterances including attached questions, since these types of questions are signaled by the rising intonations "3-2 in CJA when the speaker expects confirmation and by the rising intonation "3-1 when he asks for information. Observe the following:

1) a) Doesn't he?
3- "3- 2/
(Expecting confirmation)

b) mišheek?
3-"3-2 /

2) a) Doesn't he?
3-"3- -1/.
(Asking for information)

b) mišheek?
3-"3-1 /.

(This error is seen clearly in Fig. 23.)

2.4 Summary

Table 5 is a summary of both the GAE and CJA primary intonation patterns that were described and illustrated in this chapter. On the left there is a listing of the GAE intonations, arranged according to their type, category, position in word group, and meaning. Alongside and to the right is a similar listing of the CJA equivalent intonations arranged in the same manner. In addition, there is a special column to the far right under which areas of facilitation or interference, between the contrasted intonations of the two languages, are indicated.

The following arrangement has been selected for preparing this table: Falling intonations come first, starting with "1-4, then "2-4 and so on. Next come rising intonations, starting with "4-3, then "4-2, etc. This is followed by level contours, then falling-rising contours and finally rising-falling contours in the same order of presentation.

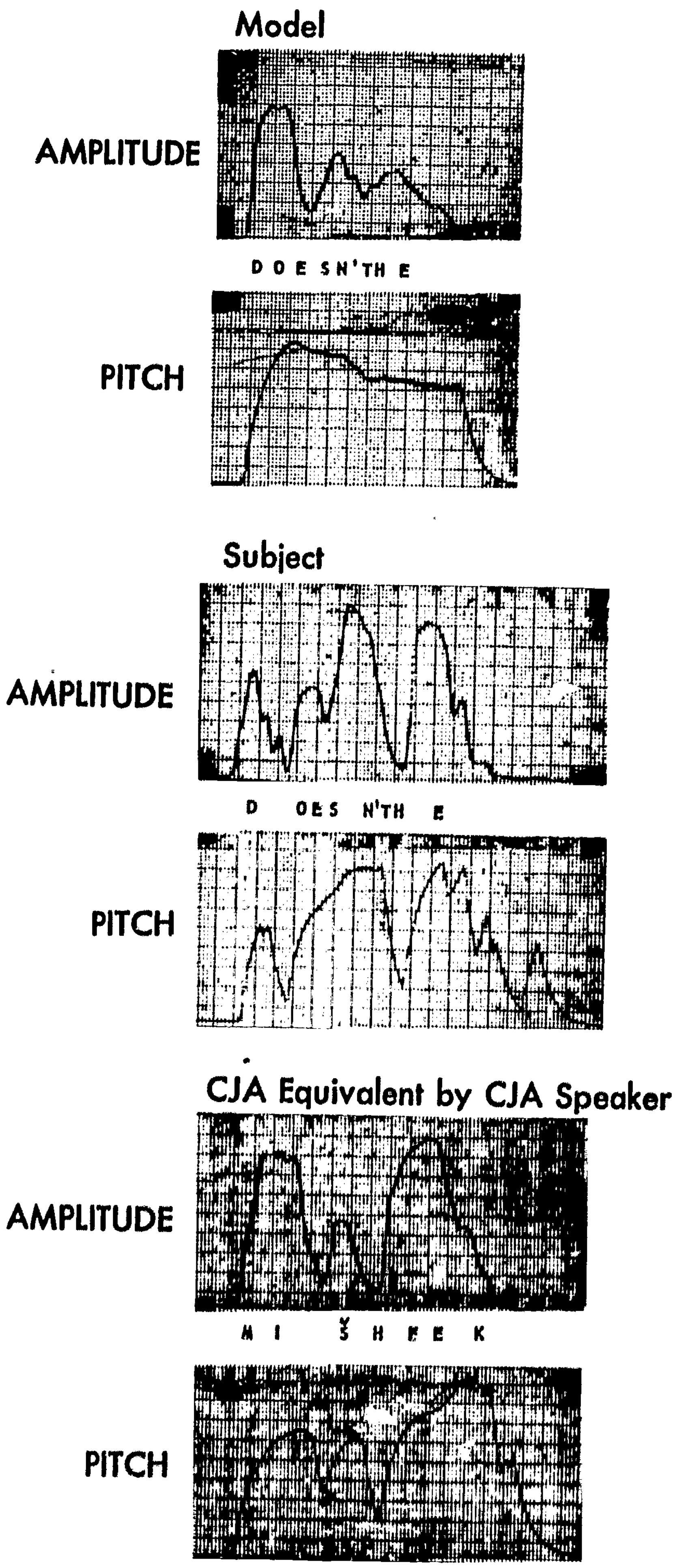

Fig. 23. Graphs showing difference with respect to changes in pitch between M and S in producing the GAE attached question.

TABLE 5

COMPARISON AND CONTRAST BETWEEN GAE AND CJA INTONATIONAL PATTERNS INCLUDED IN THE GAE SELECTED UTTERANCES AND THE CJA TRANSLATION-EQUIVALENTS

	American English				Colloquial Jordanian Arabic				
Falling	Type	Category	Position	Meaning	Type	Category	Position	Meaning	Conflict
	1-4	statements	final	intense contrastive pointing	1-3	same	non-final	same	form and distribution
	2-4	greetings	final	normal greeting	2-3	same	same	same	form
	2-4	statements	final	finality	2-3	same	same	same	form
	2-4	statements	final	mild contrast	2-3	same	same	same	form
	2-4	yes-no questions	final	contrastive pointing	3-2	same	same	same	form
	2-4	wh- questions	final	normal questions	2-3 3-3	same same	same same	same same	form form
	2-4	wh- questions	final	contrastive pointing	3-2	interrogative questions	same	same	form
	2-4	wh- questions	final	contrastive pointing (separate pronouns)	2-3	interrogative questions	non-final	same (addition of winta)	form and distribution
	2-4	wh- questions	final	contrastive pointing (possessive pronouns)	1-3	interrogative questions	same	same (suffixed pronoun)	form
	2-4	requests and commands	final	contrastive pointing	2-3	same	same	same	form
	2-4	attached questions	final	expecting confirmation	3-2	same	same	same	form
	2--4	greetings	final	cheerful greeting	2-3	same	same	same	form
	1-3	statements	non-final	less intense in contrast than 1-4 plus non-finality	1-3	same	same	same	none
	2-3	statements	final	moderate contrast	2-3	same	non-final	same	distribution
	2-3	yes-no questions	final	contrastive pointing	1-3	same	non-final	same	form and distribution
	2-3	wh- questions	final	contrastive pointing	2-3	interrogative questions	non-final	same	distribution

Rising	Type	Category	Position	Meaning	Type	Category	Position	Meaning	Conflict
	4-1	exclamatory sentences	final	surprise plus unexpectedness	2-1	same	same	same	form
	4-2	yes-no questions	final	contrastive pointing	3-2	same	same	same	form
	4-2	exclamatory sentences	final	surprise plus unexpectedness	1-3	same	same	same	form
	4-2	attached questions	final	asking for information	3-2	same	same	same	form
	4-3	exclamatory sentences	non-final	surprise plus unexpectedness	2-2	same	same	same	form
	3-1	exclamatory sentences	final	surprise plus disbelief	3-1	same	same	same	none
	3-2	statements	final	contrastive pointing	2-3	same	non-final	same	form and distribution
	3-2	yes-no questions	non-final	contrastive pointing	2--2	same	same	same	form
	3-2	wh- questions	non-final	contrastive pointing	3-2	interrogative questions	same	same	none
	3-2	requests and commands	non-final	contrastive pointing	2-3	same	same	same	form
	2-1	wh- questions	final	echo question	3-2	interrogative questions	same	same	form
Level	3-3	requests and commands	final	polite request	3-2	same	same	same	form

	Type	Category	Position	Meaning	Type	Category	Position	Meaning	Conflict
Falling-Rising									
	1-4-3	wh- questions	final	question repeated with surprise	3-1-3↗	interrogative questions	same	same	form
	2-4-3	statements	final	contrast plus surprised attention	1-3	same	same	same	form
	2-4-3	yes-no questions	final	contrastive pointing	2-3	same	non-final	same	form and distribution
Rising-Falling									
	2-1-4	greetings	final	friendly greeting	3-2-3	same	same	same	form
	3-2-3	requests and commands	final	expressing annoyance	1-3	same	non-final	same	form and distribution
	3-2-4	yes-no questions	final	contrastive pointing	2--2	same	same	same	form
	3-2-4	exclamatory sentences	final	surprise plus disbelief	2-3	same	same	same	form

CHAPTER FIVE

EFFECTIVENESS OF SAID IN ANALYZING PROSODIC FEATURES

5.1 Introduction

As indicated in Chapter 1, one of the basic goals of this research is to evaluate SAID as an electro-mechanical device for analyzing prosodic features of languages. For this purpose the listening experiment was designed. The results were compared and contrasted with the results of SAID analysis.

There are two points that should be made clear at the outset: (1) This chapter does not provide conclusive evidence of the effectiveness of SAID, since this device needs further development before its effectiveness can be fully proved. (2) This chapter will not go into further details concerning the development of instrumental techniques of analysis or the various studies related to it. For those readers who would like to know more about instrumental analysis and its development, Pike has included a detailed description of this topic in Chapter 2 of <u>The Intonation of American English.</u>

Before comparing the results obtained from the listening experiment[1] with those obtained through use of the SAID in connection with analysis of prosodic features of the selected English utterances,[2] and the CJA translation-equivalents,[3] the results of each analysis will be discussed separately.

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[1]For details about the listening experiment, see Appendix II, pp. 170-206.

[2]See Appendix I-B, pp. 163-164.

[3]See Appendix I-C, pp. 165-168.

5.2 Listening Experiment

An important observation on the consensus of the listening experiment is the lack of complete agreement among the listeners' reactions. There are only a few cases where the listeners' markings of primary pitch contours and stress points all agree. There are also a few cases where there is complete disagreement. On the whole, however, at any point, four or five out of the seven listeners are in agreement in their perception of pitch or stress changes.[4]

Another interesting observation is that, sometimes, there is little consistency in the listeners' reactions. Some of them asked me to play the tape back once or twice to check on their first judgment. Their initial decision was often changed according to their attitude towards the pattern at different times.[5]

In general, the final markings of intonation contours and stress points are carefully done. Nevertheless, checking on the direction of intonation contours, their length, their height, their beginning and ending points, their stressed and unstressed syllables, I have found divergences among the listeners' reactions. This, I assume, is influenced by their individual language backgrounds, and the individual variation in aural sensitivity of each one to intensity and frequency.[6]

All these factors combined made it rather difficult in comparing the utterances produced by both English informants and Jordanian Ss in order

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[4]See Appendix II-H, I, pp. 190-198.

[5]Similar conclusions were reached earlier by Pike in his volume The Intonation of American English, Chapter 2, pp. 14-15.

[6]Ibid.

to establish a definitive judgment concerning the problems involved. Although dependence on the majority of the listeners yielded good results, later confirmed by SAID analysis, extraneous elements influenced their judgment. There were inaccurate guesses about some of the degrees of stress and pitch, or the direction, length, and height of some intonation contours.[7]

5.3 SAID Analysis

The graphs produced through SAID allow the reader to recognize intonation contours and degrees of stress with facility and certainty. SAID reaction is not subject to the sudden vagaries of perception that influence human judgment.

SAID analysis locates intonation contours and stress points very consistently. Its reaction is not at all influenced by analysis of previous utterances, since it is formulated by a real-time, electro-acoustic analysis of intensity and fundamental frequency.

With regard to the description and measurement of the prosodic features under study, SAID provides accurate and adequate information. The diagrams produced by SAID, and the spectrograms that were especially made to supplement these diagrams, made it easy to determine the direction of pitch contours, their heights, and their starting and ending points.

In comparing and contrasting the utterances for analysis as they were performed by Ms and Ss, SAID offers great help. If we take two of its graphs, one for M and another for S, and examine their pitch and amplitude peaks as well as tempo distances, considering the mathematical values for each peak, we will get a clear and true picture of the areas of interference between the prosodies of the two languages.

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[7] See Appendix II-H, I, pp. 190-198.

5.4 Auditory Analysis vs. SAID Analysis

It is very important to compare the results found by the listening experiment with those obtained by use of SAID analysis in connection with analysis of the prosodic features of the selected English utterances as performed by the English informants and the Jordanian Ss.

Although the agreement between the two analyses is close in some points, the SAID analysis has characteristics that encourage me to say that its judgment is more satisfactory and accurate for the specification of the actual phonic substance of the prosodies than auditory analysis. For example, the graphs produced by SAID enable the reader to recognize intonation and stress problems with facility and certainty, whereas mere hearing of the human ear does not determine these physical parameters as well.

The graphs with their pitch peaks, amplitude peaks, and tempo intervals help in noting likenesses and differences more quickly and accurately than the ear, which needs more time to discriminate these things. SAID is superior to the ear in determining these areas of interference and facilitation, since it facilitates recognition of the problems when we compare both the Ms' and the Ss' performances. Some of the listeners asked me to play the tape back two or three times just to be sure of the pitch contour or the degree of stress they were trying to determine. Unlike listeners who differ in their sensitivity to pitch and amplitude changes, SAID gives only one judgment avoiding all distraction.

SAID analysis is objective. It is not influenced by the attitude of the individual toward the pattern he listens to.

The diagrams supplied by SAID, with the help of some spectrograms and mingograms (amplitude section), clearly show differences in the direction of each intonation contour, its speed, its length, its height, its beginning and ending points as well as its stressed and unstressed parts. (See Figs. 24 & 25) The ear can not give all this information which is especially relevant when we deal with rising-falling and falling-rising intonations where glides are involved.

On the whole, both auditory and SAID analysis are needed, since each one complements the other. In spite of the superiority of SAID analysis over auditory analysis, we should recognize that the linguistic interpretation of the phonic data must, of course, depend on human judgment.

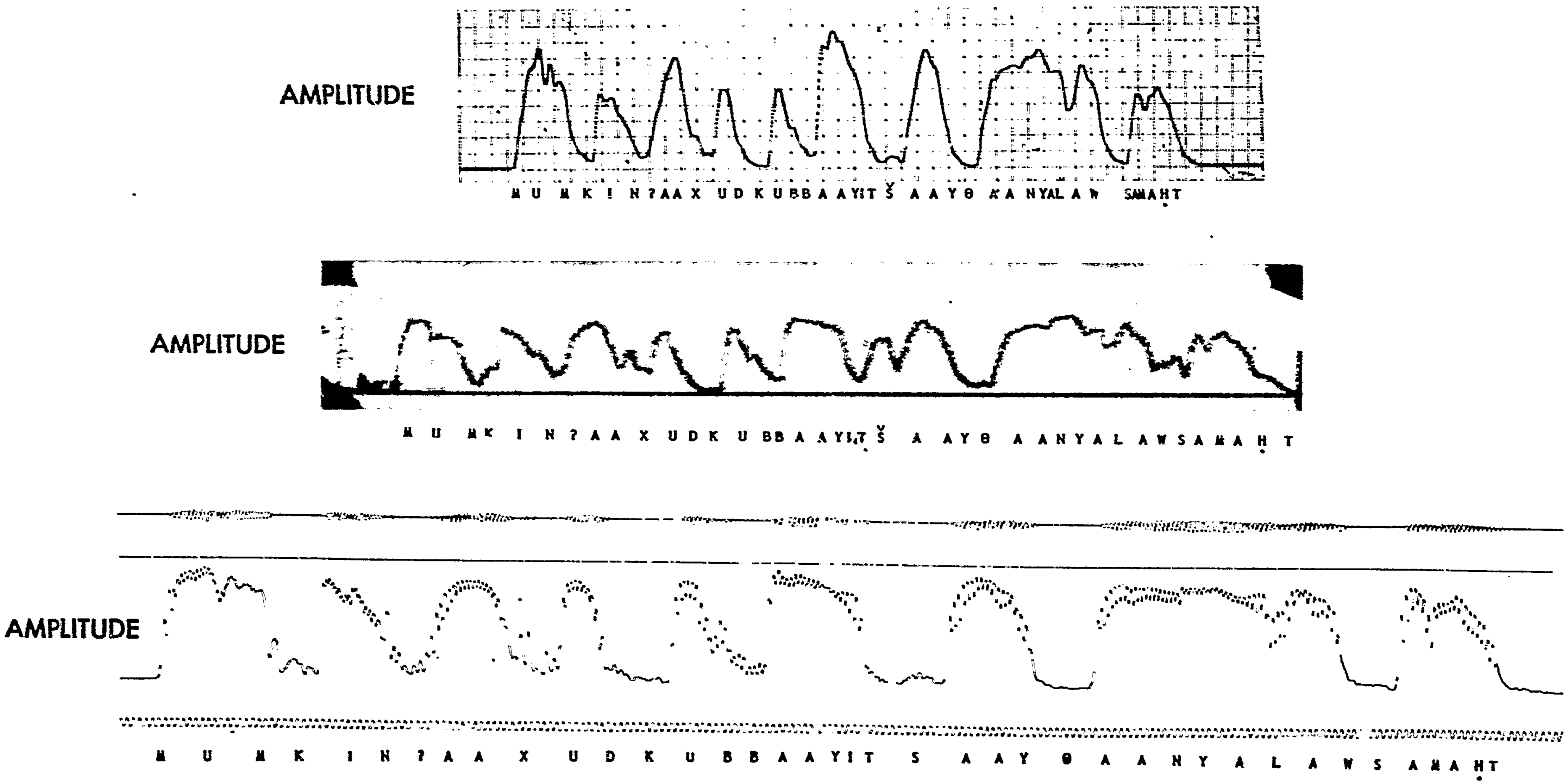

Fig. 24. An example of SAID judgment with respect to amplitude as compared with spectrograms and mingograms.

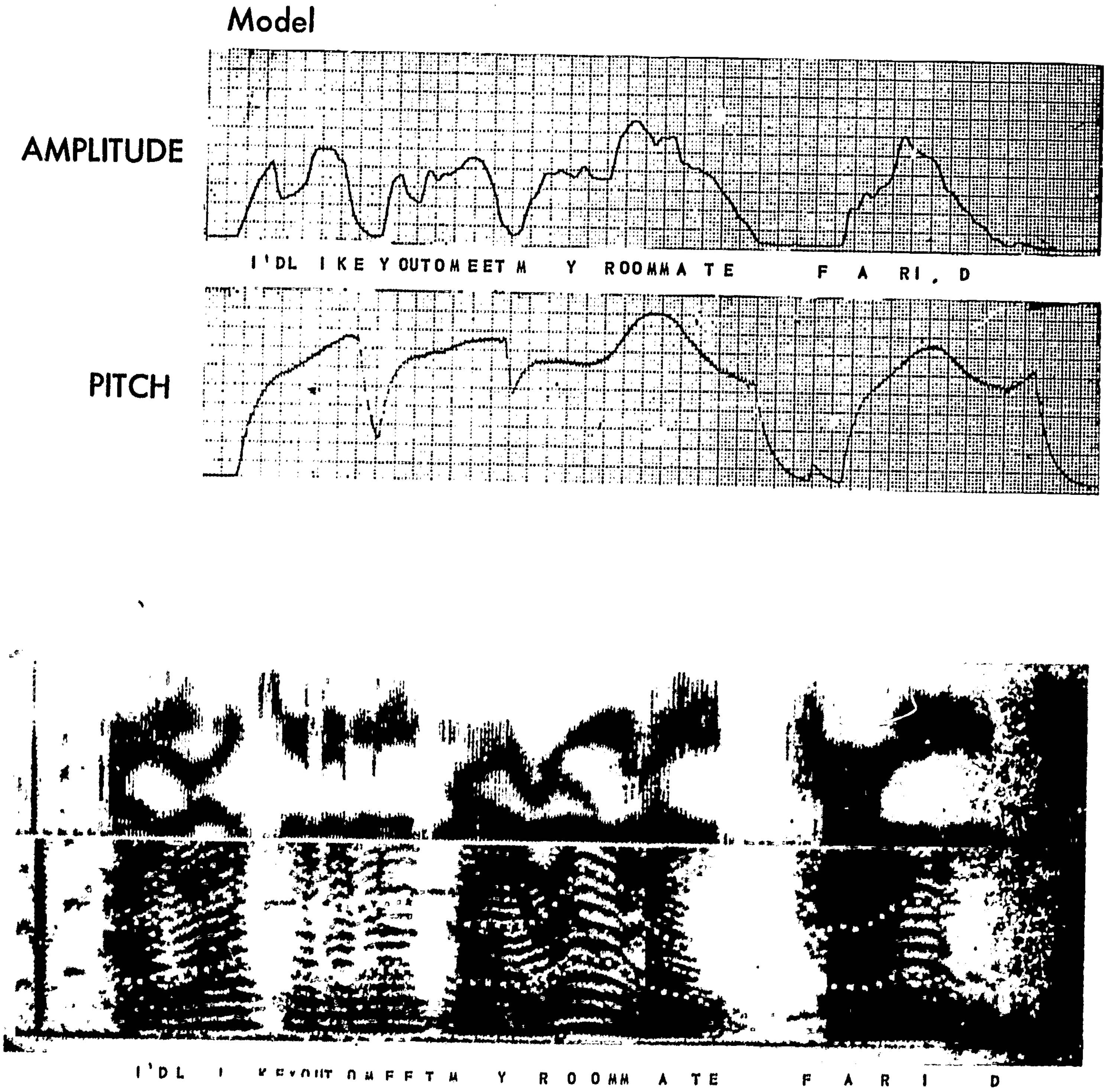

Fig. 25. An example of SAID judgment with respect to pitch as compared with spectrograms.

CHAPTER SIX

EFFECTIVENESS OF SAID IN TEACHING A PROGRAMMED UNIT

6.1 Introduction

This experimental unit is one example of the possible uses of the information gathered in this research. It is intended to meet the need for improvement of the intonation of English by Jordanian students, concentrating on a specific area identified in this study. The frames are designed to reflect the students' real environment as well as their knowledge of English. Because the frames employ lexical material that is familiar to the students, this program is made more meaningful.

The program consists of two parts: recognition and production. The first part is designed to teach discrimination between correct and incorrect pronunciations by different speakers, emphasizing differences in stress and intonation. The second concentrates on active practice in producing the proper GAE "2-4 intonation contour in imitation of a model speaker. Other related elements, such as loudness and tempo, are also provided for.

6.2 Objectives

This program was designed mainly for use with SAID[1] to teach the GAE "2-4 intonation as used in statements to an experimental group of Jordanian students. Its specific aims are:

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[1]The program can also be used in situations where SAID is not available. In this case, any student can use the program provided that: (a) he has a copy of the program (student's copy does not include stress and intonation marks); (b) the material is put on tape to provide for recognition and production goals, and (c) a teacher is present, especially in the production part, to evaluate the student's performance and guide him accordingly.

1. To enable students to distinguish between correct and incorrect pronunciation, through listening to tape-recordings of different speakers and then giving their judgment. The material recorded emphasizes stress and intonational differences.
2. To enable students to recognize the use of the intonation pattern "2-4 in statements. Students should be able to demonstrate their recognition by answering some questions in this connection.
3. To enable students to recognize the stress proper to the statement intonation pattern "2-4.
4. To enable students to produce correctly the intonation pattern "2-4 in statements, with the use of a model.
5. To enable students to produce the stress proper to the intonation pattern "2-4 as used in statements.
6. At the end of the program, to test mastery of this intonation pattern, students' performances will be judged acceptable if they produce correctly at least 80%[2] of both
   (a) written answers given in response to the model, and
   (b) a controlled conversation with an American native speaker, where the Jordanian student will be using statements in his response.

6.3 Method and Procedure

The material prepared for this program was recorded by three native speakers of American English and one non-native speaker. The recording was made in a sound-insulated booth. To help the model speaker, stress marks and arrows were included to indicate proper pronunciation, as well

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[2] This criterion was selected on the basis of preliminary experiments with SAID. For details see: Buiten, R., and Lane, H., op. cit., p. 10.

as the direction of final pitch contours. For example, an upward arrow ↑ signals a rising pitch contour, a downward arrow ↓ signals a falling pitch contour, and a level arrow → is used for a level pitch contour where there is no rise or falling of the voice.

Three Jordanian Ss helped in developing this program. The Ss were pre-tested before they started the program. The pre-test included two items. First the S was asked to answer five questions. The answers to these questions were provided to help the S look at them, before he uttered them. Secondly, the S was asked to carry on a controlled written conversation with an English speaker where the former used statements in his responses. In both cases the S's performance was tape-recorded.

This initial recording of the Ss was obtained for two purposes: (a) to check on their errors in producing the prosodic features (pitch, amplitude and tempo) of English before they used SAID, and (b) to compare their performance in the pre-test with their control of the same items in the Post-test (which was given after the Ss had actively practiced producing these items through SAID).

In both the recognition and production parts of this program, the Ss individually used a sound-insulated booth. In the first part, each S was asked to listen to a tape-recording of several different speakers, and then respond to the questions asked. The S was instructed to respond by pressing two buttons connected to a modified tape-transport mechanism. This device presented auditory stimuli to the S, confirmed his responses as correct or incorrect, and made a cumulative record of his performance. In addition, the S's responses to each stimulus were graphically recorded in the form of a strip chart that permitted a ready analysis of the learning that had taken place.

The production part of the program used SAID rather than the tape-transport mechanism. The S was asked to listen to pattern statements, then, when the light on his panel flashed, to imitate the "pitch" contour of the pattern. During his imitation, the meter on his panel indicated the acceptability of his performance by showing the amount of his error in relation to tolerance levels set for accurate imitation. When the S's imitation was unacceptable, SAID rewound the tape-recorder and presented the same pattern statement to him again. The S kept imitating the "pitch" contour of the pattern until his imitation was acceptable. After accepting his "pitch" contour, the device turned on the light for "amplitude," and the same procedure was repeated. When the S's "amplitude" was acceptable, the same steps were repeated for "tempo." The S had to demonstrate an acceptable imitation of all three prosodic features of the pattern concurrently on three successive trials before SAID presented him with the next item.

The computer's teleprinter, during this preceding process, typed a running record of all the S's trials. The teleprinter started typing "pitch," the first feature that the S was to imitate. Then, it typed the letter "p" for the pattern, and the letter "s" for the student or subject before it processed the S's imitation. This was followed by typing the results of each comparison of the pattern and the S's imitation. When the S's imitation was unacceptable, the teleprinter repeated the sequence. Otherwise, it typed the next feature, "amplitude," followed by "p" and "s," and, as usual, compared the pattern with the S's performance. The same sequence was repeated for "tempo." When the S had thoroughly mastered the pattern, and was ready to be presented with the next item in the program, the teleprinter typed out a table of the results for all the S's trials for pitch, amplitude and tempo.

6.4 Instructions to the Student

Before starting this program with SAID, the S was asked to read the following instructions:

1. The material of this program is presented in the form of small steps (frames) which appear one after the other on successive pages. The correct answer for each frame is given in the left column on the next page, before the item that follows.
2. Each frame (except for a few that are included just to give instructions) requires you to give an immediate response. In the first part (the recognition part), you are asked to give answers to some questions. Please respond by merely pressing one of the two buttons that will be available for your use in the booth you will be seated in. Press the right button for positive answers and the left one for negative answers.
3. After each response in the recognition part, check your answer by watching the light which immediately flashes under the button you press if your answer is correct and under the other button if the answer is incorrect.
4. In the second part of the program (the production part), you will be asked to imitate some English pattern statements. First, listen carefully to the pattern, and then give your imitation when the respond light on your panel tells you to do so. SAID starts with the "pitch" contour of the pattern.

You may spend 1-5 minutes on the "pitch" contour of one pattern, before the device accepts your imitation. Afterwards, SAID turns on the light for "amplitude" and you will continue imitating the same pattern as you did before. When your imitation of "amplitude" is acceptable, the device turns on the light for "tempo." Here, SAID requires you to imitate the same pattern that you have been practicing, until you demonstrate an acceptable imitation of all three prosodic features on three successive trials. After that you will be presented with the next item in the program. It may take you from 2-10 minutes or more to produce only one pattern accurately. Please do not be impatient. The main purpose of the whole learning process through SAID is to enable you to acquire mastery of English prosody.

5. You will be orally instructed about the operation of the SAID in the booth you will be seated in, before you begin this program. However, if you need help at any time during the learning process please ask your monitor who will be waiting outside your booth to answer your questions and to assist you in whatever way possible.

6.5 Program Content

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available from the author on request.

6.6 Effectiveness of SAID in Teaching Prosodic Mastery

As mentioned in Chapter 1, one of my main intentions in this research is to evaluate the effectiveness of SAID in teaching a programmed unit, designed to improve the fluency in the prosodic features of GAE, to an experimental group of Jordanian students. First, however, it seems necessary to say a word about the development and functions of the SAID system.

In 1961, Dr. Harlan L. Lane and Roger L. Buiten designed a new electro-mechanical device for teaching prosodic accuracy at the Behavior Analysis Laboratory of the University of Michigan. This new teaching device, called SAID, was developed and put under experimentation in 1963. According to Lane and Buiten, SAID can:

> "1) provide the student with rapid, reliable, and valid evaluation of his prosodic accuracy, and 2) adapt the learning sequence in accord with the student's proficiency at each step along the way."[3]

The authors describe the major functions of SAID as follows:

> "SAID is an electro-mechanical device which performs three significant functions in conditioning prosodic accuracy in a second language. First, SAID presents to the student tape-recorded pattern sentences that are considered standards in prosodic performance. These sentences are programmed in the best known sequence for teaching prosody in the target language to a speaker of a given native language. The student is instructed to imitate the pattern sentence after he hears it. Second, SAID processes the student's imitation, and instantaneously evaluates its acceptability on the basis of its three distinct prosodic features: pitch, loudness, and tempo. Third, SAID immediately displays to the student the degree to which his imitation is unacceptable, and demonstrates how he must modify his next imitation, in the prosodic feature under consideration, in order to make the imitation more

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[3] Buiten, R. & Lane, H. *op. cit.* p. 6.

acceptable. This process of presentation-evaluation-display repeats itself until the prosody of the student's imitation is acceptable."[4]

My evaluation of the effectiveness of SAID in teaching the programmed unit included in this research is based on the following sources: 1) analysis of the records obtained from the tape-transport mechanism and the computer's teleprinter; 2) the results obtained through comparison of the Ss' performances in both the pre-test and the post-test; 3) the reactions of the Ss, and 4) my own observation of the Ss during the learning process.

Analysis of the records obtained from the tape-transport mechanism revealed that the Ss had no trouble in recognizing differences in stress and intonation, especially when both correct and incorrect pronunciations of the same utterances were given in contrast. Most of the Ss' errors occurred in frames that did not give contrastive pronunciations. This necessitated revision of the first draft of the program in order to provide for more practice in distinguishing between correct and incorrect pronunciations, before the Ss were asked to judge acceptable or unacceptable pronunciations by merely listening to one utterance alone instead of two in contrast.

In like manner, the records produced by the computer's teleprinter described the learning that had taken place in the production part of the program. Here, the Ss had particular difficulty with the following: (a) patterns including words of more than three syllables; (b) patterns including reduced forms, and (c) patterns consisting of more than ten syllables each. The trouble of the Ss, here, was due to the problem

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[4]Buiten, R., & Lane, H. op. cit. pp. 6-7.

Examination of the Ss' performances in the pre-test indicated that while, on the strictly segmental level, they had virtually no trouble in speaking or understanding Fnglish, the Ss still had the same prosodic problems that were identified in this research. For example, they gave primary stress, as well as primary intonation, to almost every word in the English utterance, giving each word its citation value in terms of length and stress. Lexical items with special emphasis were treated by the Ss just the same as other items included in the same utterance. Furthermore, the Ss' utterances sounded incomplete and unfinished when they used their CJA "2-3 final intonation, instead of the GAE "2-4 intonation.

The results obtained from the computer's comparison of four utterances,[6] as performed by the Ss in both the pre-test and the post-test, showed a noticeable improvement in the Ss' production of English statements after they had used SAID. (This is clearly seen in Table 6.) For each of the three prosodic features shown in the table, the first and third columns show each S's error in imitating the M in the pre-test and post-test, respectively. The error measures shown under "pitch," for example, give the ratio of S's changes in pitch to the M's respective changes in pitch, expressed in logarithmic units. These are the error measures displayed to the S during his imitation. For ease of interpretation, these error measures are shown in columns two and four, under each feature in the table, expressed as per cent deviation from a unity ratio of S change to M change. For example, in

[6]The first two of these utterances were selected from the first part of the test, and the other two were selected from the second part.

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TABLE

COMPUTER COMPARISONS OF S AND M IN ALL PROSODIC FEATURES OF THE THREE ENGLISH UTTERANCES: THE RATIO OF THE Ss' CHANGES IN PITCH, AMPLITUDE AND TEMPO TO THE CORRESPONDING CHANGES IN THE PROSODIC FEATURES OF THE M

UTTERANCE	TEST	SUBJECT	PITCH				AMPLITUDE				TEMPO			
			PRE-TEST		POST-TEST		PRE-TEST		POST-TEST		PRE-TEST		POST-TEST	
			log. unit	percent	log. unit	percent	log. unit	percent	log. unit	percent	log. unit	percent	log. unit	percent
1. I need a new shirt.	Part I	1	193	56	69	17	329	113	158	44	359	129	88	23
		2	278	89	147	40	389	150	123	33	311	105	134	36
		3	471	195	117	31	229	69	178	51	291	95	175	50
2. She's cooking in the kitchen.	Part I	1	234	71	96	25	284	92	229	69	177	50	199	58
		2	237	73	168	47	200	59	120	32	321	109	246	76
		3	115	30	61	15	267	85	169	48	301	100	148	41
Mean percentage for 3 Ss for utterance 1 and 2.				85		29		94		46		98		47
3. Thank you very much.	Part II	1	448	180	103	27	320	109	157	44	270	86	187	54
		2	349	123	119	32	167	47	174	49	343	120	227	69
		3	117	31	129	35	289	95	114	30	379	139	214	64
4. I like Arab food better.	Part II	1	358	128	247	77	331	114	187	54	372	136	221	66
		2	302	100	274	88	283	92	218	65	281	91	219	66
		3	194	56	177	50	251	78	211	63	364	131	188	54
Mean percentage for 3 Ss for utterance 3 and 4.				102		51		90		51		117		62

utterance 1, S 1, pitch pre-test, an error of .193 log. units corresponds to a ratio of S's pitch change to that of the M of 1.56 or a 56 per cent deviation.

On this basis, the computer's analysis of the two utterances selected from the first part of the test shows 85% error in the pre-test, compared to 29% error in the post-test for pitch; 94% error in the pre-test, compared to 46% in the post-test for amplitude, and 98% error in the pre-test, compared to 47% error in the post-test for tempo (i.e., 56% improvement in pitch, 48% improvement in amplitude, and 42% improvement in tempo). Likewise, the results obtained for the other two utterances selected from the second part of the test were: 102% error[7] in the pre-test vs. 51% error in the post-test for pitch; 90% error in the pre-test vs. 51% error in the post-test for amplitude, and 117% error in the pre-test vs. 62% error in the post-test for tempo (i.e., 51% improvement in pitch, 39% improvement in amplitude, and 55% improvement in tempo).

In conjunction with this analysis, Professor Catford was kind enough to devote time to analyze the S's performances in the pre-test, marking the tonic syllables[8] of each utterance for each S. The same procedure was repeated for the post-test. He then compared the markings of the tones or intonation contours of similar utterances for each S in

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[7] A 100% error means that the change in the S's prosodic features was double that of the M; a 200% error means it was triple that of the M, etc.

[8] By the tonic syllable is meant the one which carries the main pitch movement in the utterance and, indeed, is what is often called the syllable bearing "sentence stress."

both tests, checking on the S's incorrect location of the tone. In rating the Ss' performances, he took off one mark for incorrect location of the tonic syllables and a half mark off for noticeable error in actual tones (e.g., using "2-3 instead of "2-4). The average percentage of the incorrect location of the tonic syllables by the three Ss, in the first part of the test, was found to be 75% in the pre-test compared to 10% in the post-test (i.e., 65% improvement). In the second part of the test, the average percentages were about 50% error in the pre-test and less than 10% error in the post-test (i.e., 40% improvement). The differences in the percentages obtained for the Ss' performances in both tests gave evidence for the improvement of the pronunciation of English, in general, by the Jordanian Ss. These results also confirmed the results obtained from the comparison made by the computer as shown in Table 6.

During the learning process, the Ss reported that, at its most efficient phase, SAID's effect upon them was like that of a "private tutor." But, when the acceptable limit was set at a narrow level, they felt that SAID learning was "boring" and "confusing." The Ss were also not satisfied with the meter on their panel which indicated their error during the process of imitating the pattern. They felt the need for a teacher to be present during the learning process, to help them know where their errors occurred and to guide them towards the accomplishment of the desired pronunciation.

In the light of the combined details mentioned above, the pros and cons of the SAID system will now be stated. First, the results of the post-test as well as the records of the Ss' trials in mastering the patterns, have established that mastery of second language prosody can be achieved through SAID.

SAID's continuous record of the Ss' performance made it possible to identify the error-functions for all three prosodic features for each S. This permanent record described the performance of the Ss during the learning process. Figures 26, 27 and 28 are graphic representations of the trials in which one S attempted to imitate accurately the three prosodic features of the pattern statement, London is the capital of England. The figures show the error-functions for the three prosodic features of the pattern. In Fig. 28 notice how the S's imitation of tempo was acceptably repeated on three successive trials instead of one, because tempo is the last prosodic feature in the pattern given. The last two trials includes testing of the other two prosodic features.[9]

SAID reinforced the S for every correct response. Such immediate feedback was very helpful in three ways: 1) it activated the S's behavior, 2) it held his interest, and 3) it helped in directing his behavior to the accomplishment of his ultimate goal. The Ss were seen working with satisfaction and enthusiasm in order to achieve accurate production of the pattern.

Like a good teacher, SAID required that a given pattern be thoroughly mastered before the S was presented with the next item in the program. Since learning through SAID is done step by step, the learner is presented with a new challenge only when he is ready. This procedure conforms to modern theories of learning which put special emphasis on "readiness" and "interests of learners" as two major factors in the learning process.

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[9] See p. 111.

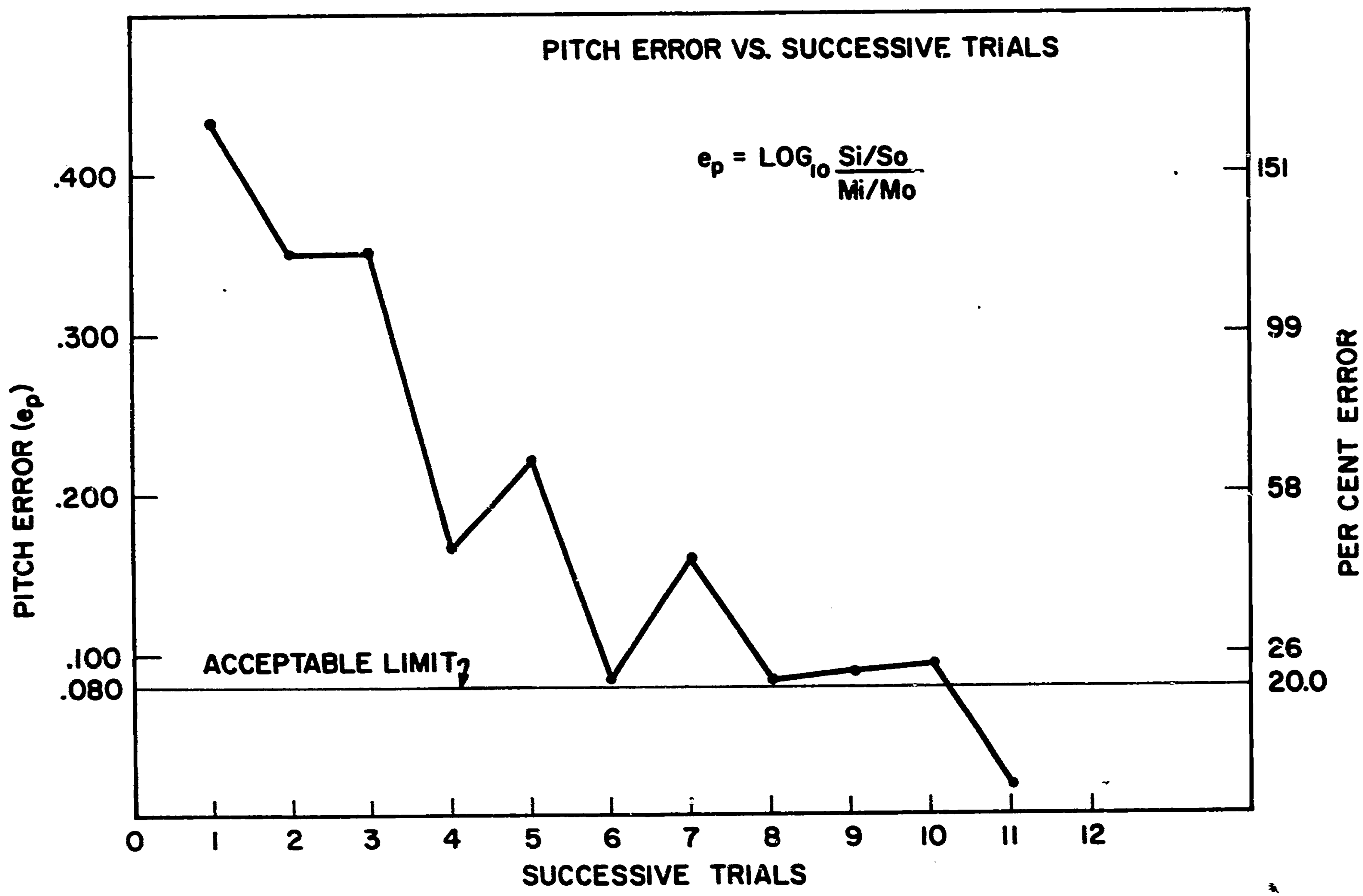

Fig. 26. An illustration of pitch error versus successive trials by S, during his imitation of the pitch of the pattern statement, London is the capital of England.

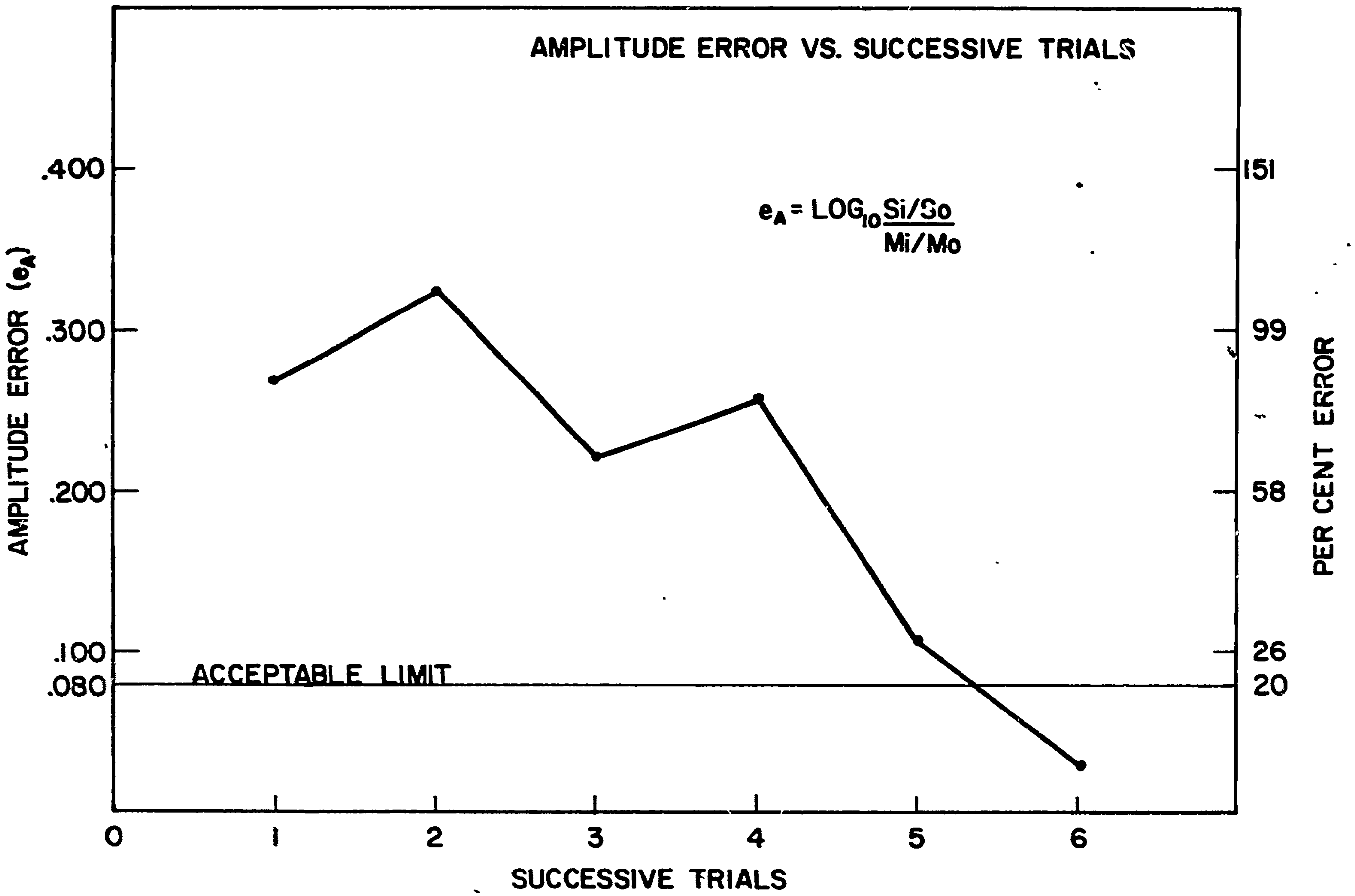

Fig. 27. An illustration of amplitude error versus successive trials by S, during his imitation of the amplitude of the same pattern statement indicated in Fig. 26.

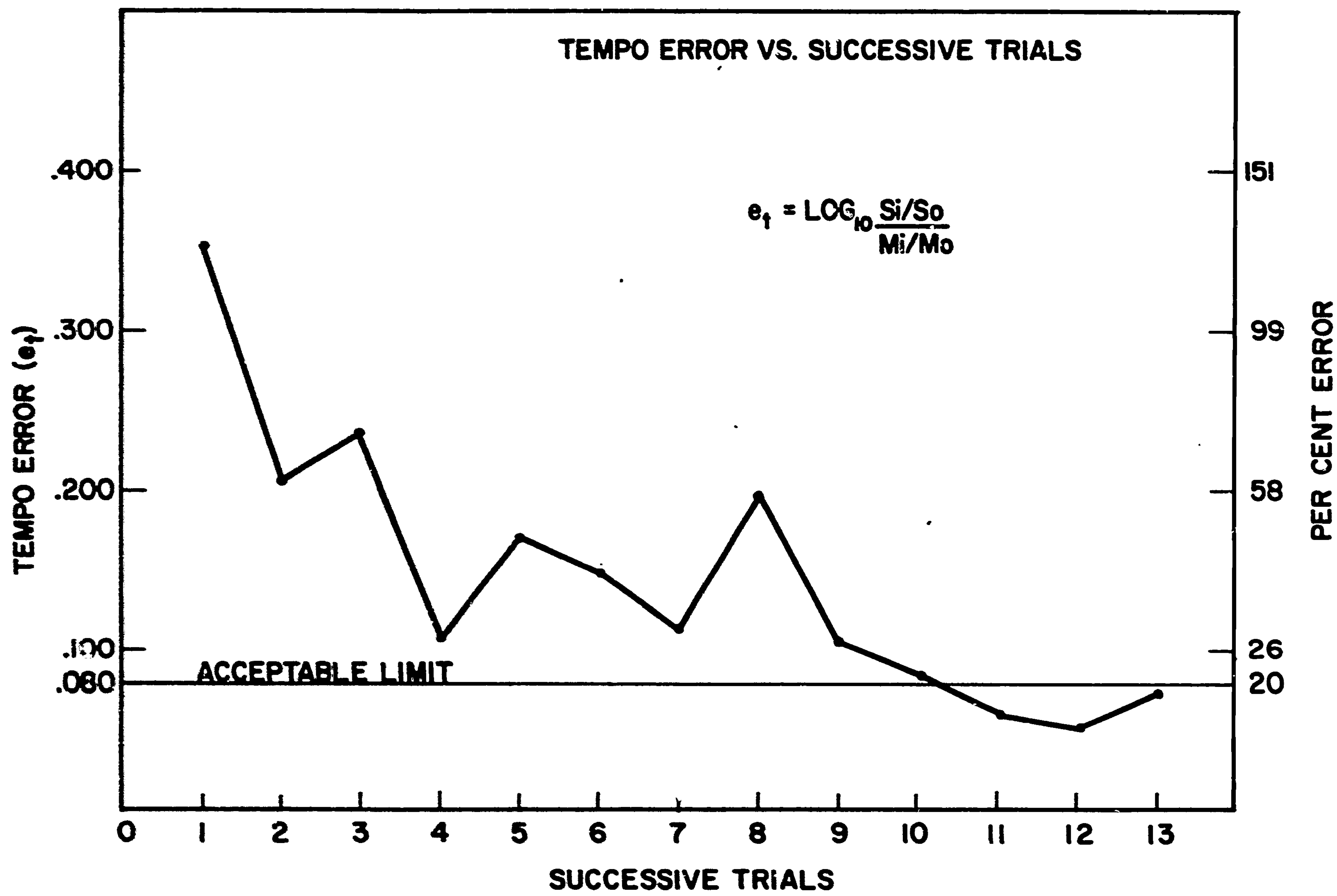

Fig. 28. An illustration of tempo error versus successive trials by S, during his imitation of the tempo of the same pattern statement indicated in Fig. 26.

Although the process of learning through SAID was slow, the post-test (See Table 6) revealed that good quality of learning could be achieved through this new modern technique of teaching prosody. The Ss transferred the new habits of stress and intonation, which they acquired through SAID, to other situations demanding the use of statement patterns similar to those which the Ss practiced through SAID. The Ss produced the correct stress and intonation patterns of nearly all the answers included in the conversation, which they were given as a part of the post-test, at the end of the program.

While the general effectiveness of SAID is demonstrated by the above observations, there are still areas which need improvement. For instance, SAID uses six levels of tolerance to evaluate the learner's performance, all of which were tried in this experiment. Examination of the results obtained from the record of trials, and observation of the Ss while they were imitating the patterns, revealed that the first level was not satisfactory in its evaluation of the Ss' performance in comparison with the pattern. The tolerance given the Ss here was too broad to take account of most errors. The second level seemed better than the first, since the imitation accepted by SAID at this level was also accepted by some native speakers of English. However, linguistically trained listeners who attended the experiment preferred levels 3 and 4 to level 2, because the device was more sensitive here in indicating the Ss' errors. Set at level 5, SAID was still more sensitive in its acceptance of the S's imitation; this degree of sensitivity increased as the level of tolerance became narrower at level 6. At levels 5 and 6 the demands of SAID were so great that the Ss had extreme difficulty in meeting them.

Learning through SAID was a slow process. Even when the tolerance was set at levels 2, 3, or 4, it took some of the Ss from 5-25 minutes to produce one pattern correctly. This length of time, occasionally, had a bad effect upon the Ss, who instead of maintaining the enthusiasm and interest that they showed while the learning process was running smoothly and easily, became confused, bored, and impatient.

Another problem associated with SAID is the question raised by Ss concerning possible availability of a teacher or a monitor during the learning process. Although the Ss had thoroughly mastered the patterns presented by SAID, they felt that there had been times when they needed a teacher to help them know where their errors occurred, and to guide them towards correct pronunciation, instead of letting them rely solely on SAID. The Ss thought that learning in the former situation would be more meaningful to them since it would help them to remember how to use the patterns that they learned through SAID correctly in their daily conversations.

One of the serious problems of SAID is its cost ($100,000). So far, not more than one student can use the system. Furthermore, there must always be a technician available to check on the system in case something goes wrong during the period of instruction.

Technical obstacles occurring while SAID is in use are also a problem. The technical issues faced while running this experiment hindered the whole learning process for a day or more, and at the same time disappointed the Ss.

The sensitivity of SAID in indicating errors made by the Ss, especially when the levels of tolerance are narrow, is another problem. The Ss, who expected improvement in their pronunciation after repeating the pattern several times, were disappointed when the device rejected their imitations because of some small variations between their performances and the criterion set for accurate imitation. Two of the Ss expressed their impatience with SAID, when it took them a step or two backwards instead of advancing them a step forward during the learning period. For instance, after the S had achieved acceptable imitation of "tempo," the device tested "pitch" and "amplitude" concurrently. And, in case there was an error with either feature, SAID recycled the whole process in order to evaluate the S's performance again, before it presented him with the next item in the program.

SAID's comparison tends to be less effective with long words included in the pattern to be imitated, since there is a tendency on the part of the S to increase or decrease the number of peaks in these words during his imitation of the pattern.

To summarize, learning through SAID is time-consuming; it requires patience and perseverance on the part of the learner until he becomes used to it. Moreover, at this point, it is very expensive. Technicians and teachers or monitors must be available most of the time in order to provide help. Nevertheless, learning through SAID (when the levels of tolerance are reasonable) results in a noticeable improvement of the learner's pronunciation. In addition, SAID makes learning very interesting and meaningful, since it activates the learner's behavior, and helps in directing it to the accomplishment of his goal. Teaching prosodic accuracy through SAID (after most of its serious problems are eliminated) would be effective, especially in situations where the number of students is small, and where native teachers of the second language in use are not available.

CHAPTER SEVEN

SUMMARY AND CONCLUSION

The contrastive analysis done in this research has provided information on some major sources of interference and facilitation between the prosodies of GAE and CJA. The prosodic areas of difficulty encountered by Jordanian students when they try to communicate in GAE have been determined, relying mainly on instrumental analysis (SAID, spectrograph, mingograph) and partly on auditory analysis. The errors made by Jordanian Ss were classified into three categories: stress, rhythm and intonation. The nature of these errors was described and later interpreted in relation to any difference, found in this research, between the prosodic patterns of the two languages under study. The problems pinpointed were illustrated by examples taken from data and by graphs, spectrograms and diagrams where necessary. Following is a summary of Ss major problems:

Stress problems

It is very important to repeat that CJA lexical stress is not phonemic, while GAE is. The Ss' trouble with GAE stress patterns results from their native language habits as in the following:

1. The Jordanian Ss substituted secondary stress for a weak stress when they produced GAE utterances.
2. They tended not to lengthen sufficiently those GAE syllables receiving primary or sentence stress.
3. The Jordanian Ss pronounced GAE monosyllabic words loudly and with primary stress when they occurred in connected speech.

They tended to produce the stressed rather than the unstressed forms of these words.

4. In GAE words of more than one syllable, various incorrect levels and positions of stress were produced by the Ss. For example:
   a) in disyllabic compound words, they placed primary stress on the second syllable and secondary stress on the first syllable, as in: roȏmmáte.
   b) in some trisyllabic words, they substituted primary stress for weak and secondary for primary: yèsterdáy.
   c) in some trisyllabic words, they substituted primary stress for weak and vice versa: élèven.
   d) in words consisting of four syllables they changed weak stress to primary and primary to secondary: cȏmfórtàble.

Rhythm problems

1. The Ss pronounced the words of a GAE utterance clearly and loudly, giving each word its citation value in terms of length and stress.
2. They had difficulty in producing reduced forms in GAE connected speech.

Intonation problems

The Ss had trouble with the following GAE intonations:

1. Falling intonations ending in pitch level /4/, since the lowest pitch in CJA is pitch level /3/.
2. Most rising-falling and falling-rising intonations, because these types are rare in CJA.
3. Falling intonations at the end of questions, since CJA comparable utterances are produced with a slight rise.

The trouble the Ss had in producing these intonations and a few others is due to differences in form, meaning, and/or distribution between GAE and CJA intonational patterns.

It was noted earlier that the main purpose of this research is not to give a full description of the prosody of CJA. Nevertheless, a limited description restricted to the corpus of data has been achieved.

It has been determined that CJA has three levels of stress: first, lexical stress which is non-phonemic and occurs with regularity in words; second, contextual phonemic stress which functions on the utterance level; and third, sentence stress which is phonemic and used only in contrastive situations for special emphasis. On the lexical level there are three degrees of phonetic stress: primary [´], secondary [`] and weak [˘]. Whereas on the other two levels we have three phonemic stresses: primary /´/, secondary /`/ and weak /˘/. Any word in the CJA utterance may receive the phonemic sentence stress /"/, which is louder than the latter contextual stresses.

Three relative pitch levels exist in the CJA intonation system. These pitches have been labeled by their height relative to one another. They are referred to as pitch level /1/, the highest pitch of CJA, pitch level /2/, and pitch level /3/, the lowest pitch in CJA used for normal conversation. This contrasts with four levels for GAE.

CJA pitch levels are relative, not absolute. They may occur in all positions in a pause group; they occur initially, medially, and finally. These pitches are meaningless by themselves; they combine one with the other in order to form intonation contours that give meaning.

My data show the existence of the following intonation contours in CJA; (1) falling contours, (2) rising contours, (3) level contours, (4) one rising-falling contour, (5) one rising-falling-rising contour. Some of these contours signal special meanings, but others do not.

The data assembled in this study suggest that most of the CJA intonation contours may occur in either non-final or final positions.

CJA rhythm is found to be "word-stressed timed," though its effect often is something like syllable-timing. The very high frequency of primary and secondary stresses in a CJA utterance accounts for this effect.

The foregoing analysis reveals two significant contrastive pauses in CJA: first, non-final pause designated in this study by the symbol /, signaling tentativeness, incompleteness and unexpectedness; second, final pause designated by the symbol //. The latter is of longer duration than the former type and marks the end of complete utterances.

Some recommendations concerning techniques of analysis and pedagogy may be tentatively put forth in the light of the findings of this study:

1. A specific approach, attacking individually the problem areas located by systematic means should characterize the first stages of teaching English as a foreign language.
2. There is a need for regular sessions of oral practice, where students should be given actual practice in listening attentively to English utterances and then producing them actively.
3. Pronunciation exercises including English intonation patterns should be prepared based on the findings of this research, to be used in conjunction with the oral materials of the first English lessons at the beginning stage. These exercises must be overlearned in order to enable the student to communicate effectively with a native speaker.

4. Supplementary teaching materials should be prepared, aiming at fluency and correctness in the prosodic features of English. These materials should be used as remedial work for advanced Arab students of English.

5. There is a need for a detailed analysis of the prosody of CJA, to be taken as a solid foundation upon which the specific problems of Jordanian students learning English will be predicted and later avoided, or, if necessary, corrected.

6. Both instrumental and auditory analyses are still needed for contrastive analysis of the prosodies of foreign languages, since each one complements the other. While instrumental analysis provided us with the specification of the actual phonic substance of the prosodies, auditory analysis, on the other hand, provides us with the necessary information for the linguistic interpretation of the phonic data.

7. This study has afforded an occasion to compare two systems of pinpointing items of difficulty: one based on data gained through contrastive linguistic techniques, and the other using linguistically sophisticated methods of finding actual errors made by students and through this pragmatic process arriving at the desired information.

8. Learning through SAID is time-consuming and expensive. However, with some further development and improvement in its operation, it could be one of the most effective means of teaching prosodic mastery of a second language efficiently, especially in situations where the number of students is small or where native teachers of the target language are scarce.

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available from author on request.

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A Functional Analysis of Self-Perception: A Behaviorist's Alternative to Cognitive Dissonance Theory[1]

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Carnegie Institute of Technology

Abstract

A theoretical alternative to Festinger's theory of cognitive dissonance is proposed. The theory defended here is comprehensive enough to embrace the major findings of dissonance theorists and specific enough to account for some of the secondary patterns of data about which dissonance theory itself has had to remain mute. The proposed alternative is based on a purely behavioral functional analysis of self-descriptive attitude statements and demonstrates that self-perception is a special case of interpersonal perception. Several supporting experiments are presented, and metatheoretical contrasts between the "radical" behavioral approach utilized and the phenomenological approach typified by dissonance theory are discussed.

If a person holds two cognitions that are inconsistent with one another, he will experience the pressure of an aversive motivational state called cognitive dissonance, a pressure which he will seek to remove, among other ways, by altering one of the two "dissonant" cognitions. This proposition is the heart of Festinger's theory of cognitive dissonance (1957), a theory which has received more widespread attention from personality and social psychologists in the past ten years than any other contemporary statement about human behavior. Only five years after its introduction, Brehm and Cohen (1962) could review over fifty studies conducted within the framework of dissonance theory; and, in the five years since the appearance of their book, every major social-psychological journal has averaged at least one article per issue probing some prediction "derived" from the basic propositions of dissonance theory. In popularity, even the empirical law of effect now appears to be running a poor second.

The theory has also had its critics. Reservations about various aspects of the theory have ranged from mild (e.g., Asch, 1958; Bruner, 1957; Kelly, 1962; Osgood, 1960; Zajonc, 1960) to severe (Chapanis & Chapanis, 1964), and alternative interpretations have been offered to account for the results of particular studies (e.g., Chapanis & Chapanis, 1964; Lott, 1963; Rosenberg, 1965). No theoretical alternative has been proposed, however, which is both comprehensive enough to embrace its major sets of substantiated findings and specific enough to account for some of the secondary patterns of data about which dissonance theory itself has had to remain mute. This paper proposes such an alternative.

Like many theories in psychology, the theory of cognitive dissonance attempts to account for observed functional relations between current stimuli and responses by postulating some hypothetical structure or process within the organism, in this case, an inferred process of the arousal and reduction of dissonance. Like many other contemporary personality and social-psychological theories, dissonance theory is further characterized by an emphasis on the individual's current phenomenology; the explanatory account is ahistorical.

In contrast, the alternative formulation to be presented here eschews any reference to hypothetical internal processes and seeks, rather, to account for observed functional relations between current stimuli and responses in terms of a past history of stimulus events experienced by the individual. Such an approach has been called "radical" behaviorism (see Scriven, 1956), a position most often associated with the name of B. F. Skinner. In analyzing a complex behavioral phenomenon, the radical behaviorist attempts to establish it as a special case of some previously substantiated functional relation discovered in the experimental analysis of simpler behaviors. His functional analysis is thus based on empirical generalization and, accordingly, is frankly inductive not only in its experimental execution, but in its formal presentation.

The relative merits of these two kinds of approaches to the understanding of human behavior have often been debated (e.g., Wann, 1965). The arguments, however, nearly always remain at the metatheoretical level of analysis, and the debates typically conclude with both sides agreeing that the resolution rests upon the future heuristic value of the two approaches. The present paper may be viewed as an attempt to remove the level of debate to data "presented and accounted for."

A functional analysis characteristically begins by inquiring into the ontogenetic origins of the observed dependent variable and attempts to ascertain the controlling or independent variables of which that behavior is a function. The present analysis of dissonance phenomena proceeds in the same way, by noting first that the dependent variable in cognitive dissonance studies is, with very few exceptions, the S's self-descriptive statement of an attitude or belief. Indeed, this is the dependent variable in nearly all of contemporary social psychology. But how are such self-descriptive behaviors acquired? What are their controlling variables? It is to these questions that the analysis turns first.

Self-Perception: A Special Case of Interpersonal Perception

Interpersonal perception clearly involves something more than the individual's ability to respond to the overt behavior of other people. For example, not only does the typical husband respond appropriately to his wife's "suddenly aroused determination" when he sees her with a raised broom chasing a mouse from the kitchen into the living room, but he would have responded quite differently to her "fear" if an identical hasty entrance of the wife had been followed, rather than preceded, by the mouse. Had no mouse been present at all, he might well have described her behavior as anger directed toward him.

And yet, in all three of these cases, the overt behavior of the wife is the same. The husband, in short, responds not only to his wife's overt behavior, but he responds as well to the "intent" or to the "meaning" of her behavior. The "meaning" of the behavior, however, resides in the mouse, that is, in the stimuli that control the behavior. This, then, is the "something more" of interpersonal perception: the ability to respond not only to the overt behavior of others, but to respond as well to the variables of which their behavior is a function.

The individual who attempts to infer the "actual" beliefs or attitudes of a persuasive communicator provides a second example. Once again, the controlling variables of the behavior provide the basis of judgment: Is the communicator being paid? If so, how much? Did he volunteer to argue the position for nothing? Was he coerced? To the extent that the communicator appears to be free from the control of explicit reinforcement contingencies, that is, to the extent that he does not appear to be "manding" reinforcement (Skinner, 1957), he will be judged to be credible, and his statements will typically be judged to express his "actual" attitudes and beliefs.

If an individual is to acquire these skills of interpersonal perception, some socializing agent or community is required to teach him the appropriate discriminations. Similarly, a socializing community is required to teach an individual self-perception, the ability to respond differentially to his own behavior and its controlling variables (Mead, 1934; Ryle, 1949; Skinner, 1957). The most common responses comprising self-perception are probably self-descriptive statements, and the techniques employed by the community to teach its members to make such statements would not seem to differ fundamentally from those used to teach interpersonal perception in general. The community, however, does face a unique problem in training the individual to make statements describing internal events to which only he has direct access. To learn to describe a headache or butterflies in the stomach, for example, a child must be taught to respond only when the appropriate private stimuli are impinging upon him, but the community can undertake this training only when it has correlated public events to which it can respond at the appropriate time. Skinner (1953, 1957) has analyzed the limited resources available to the community for training its members thus to "know themselves," and he has described the inescapable inadequacies of the resulting knowledge.

This analysis implies that many of the self-descriptive statements that appear to be exclusively under the discriminative control of private stimulation may, in fact, remain under the control of the same public events that members of the community themselves must use in "inferring" the individual's inner states. In our well-fed society, for example, it is not uncommon to find a man consulting his wrist watch to answer the question, "Are you hungry?" Attitude statements often seem to be similarly controlled. For example, when the answer to the question, "Do you like brown bread?" is "I guess I do, I'm always eating it," it seems unnecessary to invoke a fount of privileged self-knowledge to account for the reply. Indeed, the man's reply is functionally equivalent to the reply his wife might give for him: "I guess he does, he is always eating it."

This functional equivalence becomes even clearer when a person is asked to state the controlling variables of his behavior: "Why do you eat at Joe's diner? The food is lousy." And the reply: "Now that you mention it, I guess the food is pretty bad. Maybe I eat there because the waitress is so cute. Yeh, I think that's probably why." Again, this man's reply appears to be based almost entirely on the kind of evidence that would be available to any outside observer; again his wife could reply for him. Recent experimental work supports this analysis by demonstrating that an individual relies heavily on his own overt behavior and accompanying external cues for judging his emotional states (Schachter & Singer, 1962), his attitudes (Bem, 1965), and the truthfulness of his own "false confessions" (Bem, in press).

In sum, then, the present analysis of the data from dissonance experiments will rest upon the single empirical generalization that an individual's belief and attitude statements and the belief and attitudes that an outside observer would attribute to him are often functionally equivalent in that both sets of statements are "inferences" from the same evidence: the public behaviors and controlling variables upon which the socializing community must rely in training its members to make such self-descriptive statements in the first place.

The Data of Dissonance Theory

The literature of dissonance theory has now become so large that it is not possible to discuss each set of findings separately. However, all but a small number of the studies can be classified into one of three main categories (Brehm & Cohen, 1962, p. 21): 1) Forced-compliance studies; 2) Free-choice studies; or, 3) Exposure-to-information studies. The major functional relation predicted in each of these three categories and the two sets of secondary findings will be discussed here. There will be no discussion of studies that use the vocabulary of dissonance theory but explore functional relations that are in no sense derivations from the major propositions of dissonance theory (e.g., studies of post-decision regret, Festinger, 1964). Nor will there be any additional discussion of phenomena that, although derivable from dissonance theory, are already considered by the dissonance theorists themselves to be as parsimoniously accounted for by straightforward empirical generalizations concerning the interpersonal judgmental skills of Ss (e.g., attitude change phenomena produced by persuasive communication); (see Brehm & Cohen, 1962, pp. 105-111). Indeed, the primary purpose of the present analysis is to extend this same kind of empirical generalizations to the very phenomena that the dissonance theorists claim to be "entirely closed to the judgmental interpretation and rather unequivocally explainable by the dissonance formulation" (Brehm & Cohen, 1962, p. 111).

The Forced-Compliance Studies

The most frequently cited evidence for dissonance theory comes from an experimental procedure known as the forced-compliance paradigm. In these experiments, an individual is induced to engage in some behavior that would imply his endorsement of a particular set of beliefs or attitudes. Following his behavior, his "actual" attitude or belief is assessed to see if it is a function of the behavior in which he has engaged and of the manipulated stimulus conditions under which it was evoked. The best known and most widely quoted study of this type was conducted by Festinger and Carlsmith (1959). In their experiments, 60 undergraduates were randomly assigned to one of three experimental conditions. In the $1 condition, S was first required to perform long repetitive laboratory tasks in an individual experimental session. He was then hired by E as an "assistant" and paid one dollar to tell a waiting fellow student (a stooge) that the tasks had been enjoyable and interesting. In the $20 condition, each S was hired for twenty dollars to do the same thing. Control Ss simply engaged in the repetitive tasks. After the experiment, each S indicated how much he had enjoyed the tasks; this was assessed in a way that maximized the possibility that S would state his actual opinion. The results show that Ss who were paid $1 evaluated the tasks as significantly more enjoyable than did Ss who had been paid $20. The $20 Ss did not express attitudes significantly different from those expressed by the control Ss.

Dissonance theory interprets these findings by noting that all Ss initially hold the cognition that the tasks are dull and boring. In addition, however, the experimental Ss have the cognition that they have expressed favorable attitudes toward the tasks to a fellow student. These two cognitions are dissonant for Ss in the $1 condition because their overt behavior does not "follow from" their cognition about the task, nor does it follow from the small compensation they are receiving. To reduce the resulting dissonance pressure, they change their cognition about the task so that it is consistent with their overt behavior: they become more favorable toward the tasks. The Ss in the $20 condition, however, experience little or no dissonance because engaging in such behavior "follows from" the large compensation they are receiving. Hence, their final attitude ratings do not differ from those of the control group.

In contrast to this explanation, the present analysis views these results as a case of self-perception. Consider the viewpoint of an outside observer who hears the individual making favorable statements about the tasks to a fellow student, and who further knows that the individual was paid $1 [$20] to do so. We then ask this hypothetical observer to state the actual attitude of the individual he has heard. An outside observer would almost certainly judge a $20 communicator to be "manding"; that is, his behavior appears to be under the control of the reinforcement contingencies and not at all under the discriminative control of the tasks he appears to be describing. The $20 communicator is not credible in that his statements cannot be used as a guide for inferring his actual attitudes. The observer would probably conclude simply that the individual found such repetitive tasks dull and boring in spite of what he had said. Although the behavior of a $1 communicator also has some mand properties, an outside observer would be more likely to judge him to be expressing his actual attitudes and would base his inferences of the communicator's attitude on what he had heard him say. He would judge this individual to be favorable toward the tasks. If one now places our hypothetical observer and the communicator into the same skin, the findings obtained by Festinger and Carlsmith are the result. There is no aversive motivational pressure postulated; the dependent variable is viewed simply as a self-judgment based on the available evidence, evidence that includes the apparent controlling variables of the observed behavior.

Festinger and Carlsmith had judges make evaluations of the communications, and they report that $1 Ss were judged to be no more persuasive than $20 Ss. But these judges were purposely not told the amount of compensation offered the communicator, and this, the present analysis implies, is precisely the information that makes one communicator more persuasive than another.

If the present analysis of these findings is correct, then it should be possible to replicate the inverse functional relation between amount of compensation and the final attitude statement by actually letting an outside observer try to infer the attitude of a S in the original study. Conceptually, this replicates the Festinger-Carlsmith experiment with the single exception that the observer and the observed are in two separate skins.

An Interpersonal Replication of the Festinger-Carlsmith Experiment

Seventy-five college undergraduates participated in an experiment designed to "determine how accurately people can judge another person." Twenty-five Ss each served in a $1, a $20, or a control condition. All Ss listened to a tape recording that attempted to provide them with the same information possessed by Festinger and Carlsmith's actual Ss. Specifically, each S was told about a college sophomore named Bob Downing, who participated in an experiment involving two motor tasks. These were described in detail, but non-evaluatively;

the alleged purpose of the experiment was also described. At this point, the control Ss were asked to evaluate Bob's attitudes toward the tasks. The experimental Ss were further told that Bob had accepted an offer of $1 [$20] to go into the waiting room, tell the next S that the tasks were fun, and to be prepared to do this again in the future if they needed him. The Ss then listened to a two minute conversation which they were told was an actual recording of Bob and the girl S who was in the waiting room. Bob was heard to argue rather imaginatively that the tasks were fun and enjoyable, while the girl responded very little except for the comments that Festinger and Carlsmith's stooge was instructed to make. The recorded conversation was identical for both experimental conditions in order to remain true to the original study in which, it will be recalled, no differences in persuasiveness were found between the $1 and the $20 communications. In sum, the situation attempted to duplicate on tape the situation actually experienced by Festinger and Carlsmith's Ss.

All Ss estimated Bob's responses to the four questions employed in the original study. These included ratings on 10-point scales of how interesting the tasks were, how much opportunity there was to learn about one's abilities, how scientifically important the experiment was, and how much S would like to participate in another similar experiment.

Results. The first question required Ss to rate the tasks [or Bob's attitude toward them] on a scale from -5 to +5 means that the tasks were extremely dull and boring, +5 means that they were extremely interesting and enjoyable, and 0 means they were neutral, neither interesting nor uninteresting. Table 1 shows the mean ratings for this question given by Ss in the three conditions of both the original experiment and the present replication.

Insert Table 1 about here

It is seen that the inverse relation between amount of payment and the final attitude rating is clearly replicated. In both studies, the $1 and control conditions are on different sides of the neutral point and are significantly different from one another at the .02 level ($\underline{t}$ = 2.48 in the original study; $\underline{t}$ = 2.60 in the replication).[2] In both studies, the $1 condition produced significantly more favorable ratings toward the task than did the $20 condition ($\underline{t}$ = 2.22, $p < .03$ in the original study; $\underline{t}$ = 3.52, $p < .001$ in the replication). In neither study is the $20 condition significantly different from the control condition; and, finally, in neither study were there any significant differences between conditions on the other three questions.

The successful replication of the functional relation reported by Festinger and Carlsmith provides support for the self-perception analysis: The original Ss may be viewed as simply making self-judgments based on the same kinds of public evidence that the community originally employed in training them to describe the attitudes of any communicator, themselves included. It is not necessary to postulate an aversive motivational drive toward consistency.

It is important to note that each outside observer in the replication judged only one S in the Festinger-Carlsmith experiment. The observers were not told about the other conditions and then asked to predict the differences between them; that is, they were not asked to predict the outcome of the Festinger-Carlsmith experiment itself. When this is done, individuals either predict no differences between conditions, or they become amateur reinforcement theorists and predict a positive relation between amount of compensation and final attitude. If a valid test of the self-perception hypothesis is to be conducted, then an outside observer must be given the same information possessed by the actual subject.

An Interpersonal Replication of the Yale Essay Experiment

The Festinger-Carlsmith study has been criticized on the basis that the $20 compensation was so large as to engender suspicion and resistance, leading Ss to think "it must be bad if they're paying me so much for it" (Brehm & Cohen, 1962, p. 74). Since this alternative interpretation is not unlike the self-perception analysis, it is relevant to examine an experiment conducted by Cohen specifically designed to rule out such an interpretation (Brehm & Cohen, 1962, pp. 73-78).

Cohen's Ss were undergraduates at Yale University, where there had just been a campus riot. The New Haven police had intervened, and most of the student body found little justification for the actions of the police. For the experiment, students were selected at random and offered $.50, $1, $5, or $10 to write an essay strongly justifying the actions of the police. After each S had written his essay, he was asked for his actual opinion on the issue. The post-essay opinions again displayed the inverse relation to the amount of compensation: the higher the compensation offered, the less the final opinion coincided with the view advocated in the essays.

The $5 and $10 conditions did not differ significantly from the control group, a group of randomly selected students who were simply asked their opinions on the issue, and the crux of Cohen's argument resides in the fact that significant differences in opinions emerged between the $.50 and $1 conditions and between them and the control condition. Since these two compensations are small and close to one another, Cohen argues that the "suspicion" hypothesis is disconfirmed. Whether or not this result implies, as well, that the self-perception analysis cannot account for the findings is an empirical question. To answer it, an interpersonal replication of Cohen's experiment was conducted. Again, each outside observer judged one--and only one--of the Ss in the original experiment.

Method. Two groups of 20 Ss each had the Yale situation described to them on a sheet of paper. They were then asked to estimate the opinion toward the police actions of a student who, for $.50 [$1], had written an essay justifying the police. An additional group of 20 Ss served as controls; they were simply asked to estimate the opinion of a randomly selected Yale Student. The complete experiment is described elsewhere (Bem, 1965).

Results. A summary of the results is presented in Fig. 1, which shows the interpersonal judgments of Ss in the replication compared with the actual opinions collected by Cohen. The scale is identical with Cohen's and assesses responses to the question: "Considering the circumstances, how justified do you think the New Haven police were in the recent riot?" Two-tailed probability levels based on t tests are also shown. It is seen that not only is the crucial inverse functional relation reaffirmed in the interpersonal data, but that the actual scale positions closely approximate those obtained by Cohen.

Insert Figure 1 about here

These results show that the self-perception interpretation of the inverse relation between amount of compensation and subsequent attitude statements is still viable. The lower the compensation, the less the observed behavior appears to be a mand, that is, behavior under reinforcement control, and the more likely it is that it will be identified by an observer, including the individual himself, as the actual attitudes of that individual.

Amount of Behavior and Attitude Statements

The Ss in the interpersonal replication just discussed did not actually read any of the essays written by Cohen's Ss, whereas Ss in the interpersonal replication of the Festinger-Carlsmith experiment did, in fact, listen to a representative persuasive communication. The successful interpersonal replication of Cohen's study thus suggests that the behavior of volunteering and its apparent controlling variables are sufficient evidence upon which to base the judgment of attitudes. This conclusion, in turn, also suggests that it may not have been necessary for Cohen's Ss to write the essays. Such is, in fact, the case. Brehm and Cohen cite a number of studies demonstrating that the predicted differential effects on attitude statements of the stimulus manipulations can be obtained even before the behavior to which the individual has commited himself is actually emmited (1962, pp. 115-116). The interpersonal replication just presented thus supports even further the self-perception analysis of these phenomena.

If volunteering to engage in the behavior suffices to produce differential attitude statements, it becomes relevant to ask what might be the additional effects of actually engaging in the behavior. More generally, what is the functional relation between the amount of behavior evoked from S and his final attitude statements?

In an experiment in which Ss were again induced to write essays, Rabbie, Brehm, and Cohen (1959) found that the mean of attitude ratings obtained before the essay is actually written is not significantly different from the mean of attitude ratings obtained after the essay is written, but that the variance across Ss is much greater in the latter case. That is, actually writing the essays increases and decreases the initial effect of volunteering.

Attempts to analyze the persuasive communications themselves have produced a tangle of findings. In the Rabbie et al. experiment, there was a negative relationship between the number of arguments and the degree to which the final attitude statement agreed with the position advocated in the essay. On the other hand, Cohen, Brehm, and Fleming (1958) report a positive relationship between "original arguments" and amount of attitude change, but this relationship appeared in only one of the experimental conditions. Unpublished data from the Festinger-Carlsmith experiment show a negative correlation in one condition between attitude ratings and "number and variety" of arguments and a positive correlation in the other. (Reported by Brehm and Cohen, 1962, p. 119.) Finally, when Ss themselves rate the quality of their persuasive communications, the confusion is only further compounded. One can concur with Brehm and Cohen that "the role of discrepant verbal behavior in the arousal and reduction of dissonance remains unclear" (p. 121). Here, then, is a pattern of findings about which the theory of cognitive dissonance stands mute. What does the present functional analysis suggest?

If an outside observer begins with the discrimination that the communicator is credible, then the more arguments put forth, the more persuasive the speaker might well become, *if* nothing intervenes to change the observer's judgment of the communicator's credibility. If, however, the observer discriminates the communicator as manding reinforcement, then it seems likely that the more insistent the speaker becomes in pushing his point of view, the more it appears to the observer that he "protesteth too much," and the less likely it is that the speaker's statements will be taken to express his "actual" attitudes.

Now consider the self-observer. If Ss in the dissonance experiments begin with the discrimination that they are not manding (Ss in the low compensation conditions, for example), then the more arguments they put forth, the more self-persuasive they might become. For any given S, however, presenting a communication counter to his initial position might itself provide him with the cues that he is manding and hence destroy the initial effect of volunteering under non-mand conditions; he will become less self-persuasive as he continues. This analysis, then, leads one to expect the increased variability in post-essay measures of attitude. It is equally clear, however, that to confirm this analysis, the hypothesized discrimination of credibility must be brought under experimental control rather than being left under the control of the unique past histories of individual Ss. The experiment described below was designed to do this.

An Extended Interpersonal Replication of the Festinger-Carlsmith Experiment

The only dissonance study that showed both a negative and a positive correlation between the amount of behavior emitted and the subsequent attitude statement in experimentally separable conditions was the Festinger-Carlsmith experiment, the experiment replicated earlier. Accordingly, this study was selected again for closer examination. These investigators found that within the $1 condition, the greater the number and variety of arguments stated by the Ss about the tasks, the more favorable his final evaluation of the tasks became. Within the $20 condition, however, the greater the number and variety of arguments, the less favorable his final rating. The present investigation, then, sought to replicate these findings with interpersonal observers.

Method. In the earlier replication, the persuasive communication heard by Ss was identical for both conditions. The Ss heard the speaker present a fairly imaginative and lengthy set of reasons as to why he had enjoyed the tasks. For the present extension, a second communication was designed, which was somewhat shorter and contained comparatively unimaginative arguments. The replication was then re-run on an additional 50 Ss assigned either to a $1 or a $20 condition. The Ss were again asked to estimate the real attitude of the speaker. Thus, except for the length and variety of arguments in the communication, this replication is identical with the earlier one. The total design, then, contains four experimental groups: $1-long communication, $1-short communication, $20-long communication, and $20-short communication.

<u>Results</u>. If the present analysis is correct, then within the $1 condition, where the communicator is more likely to be perceived as credible, the long communication should lead interpersonal observers to infer that the communicator enjoyed the tasks more than the short communication would. Within the $20 condition, however, the long communication should be <u>less</u> persuasive than the short one; the longer the speaker carries on, the harder he appears to be trying to earn his $20. He "protesteth too much." Thus, an interaction effect between the two variables of communication length and amount of compensation is predicted.

Tables 2 and 3 display the results and their analysis respectively. It will be recalled that scores can range from -5 to +5, the higher the scores, the more favorable the communicator is judged to be toward the tasks.

Insert Tables 2 and 3 about here

It is seen that the interpersonal analysis of self-perception is clearly confirmed by these results. By employing attitude estimates of outside observers, the study has replicated Festinger and Carlsmith's positive correlation between number of arguments and attitude change within the $1 condition and the negative correlation between these two variables within the $20 condition. (The main effect of compensation seen in Tables 2 and 3 is, of course, the primary "dissonance" effect reported earlier). It is further suggested that this same kind of analysis can resolve the contradictory findings obtained by "incentive" theorists using the forced-compliance paradigm (Janis & Gilmore, 1965).

Alternative Operations in Forced-Compliance Experiments

The crux of the present interpretation of the forced-compliance studies is that the evoked behavior will be used as a basis for describing the individual's "actual" attitudes both by an outside observer and by the self-observer to the extent that there appear to be no overriding contingencies of reinforcement controlling the behavior. There are, of course, many other stimulus variables that have been manipulated by the dissonance theorists other than the amount of compensation (Brehm & Cohen, 1962, pp. 303-305), but it has been argued elsewhere that every one of these operations is functionally equivalent to a manipulation of this discrimination of self-credibility (Bem, 1965).

Alternative dependent variables have also been employed in forced-compliance experiments. For example, Brehm and Cohen show that an S's rating of how hungry he is can be manipulated by inducing him to volunteer to go without food for different amounts of compensation. These investigators describe the study as an extension of dissonance theory: "What we propose is that motivational change will serve to reduce dissonance just as will attitude change" (1962, pp. 132-137). From a functional point of view, however, the dependent variable is still a self-descriptive statement, and a successful interpersonal replication of that experiment again verified the self-perception analysis (Bem, 1965). Even the few dissonance studies employing non-verbal dependent variables (e.g., Freedman 1965) are amenable to a similar, if not identical, kind of functional analysis.

The Free-Choice Experiments

In the second major category of data on dissonance theory, an S is permitted to make a selection from a set of objects or courses of action. The dependent variable is his subsequent attitude rating of the chosen and rejected alternatives. Dissonance theory reasons that any unfavorable aspects of the chosen alternative and any favorable aspects of the rejected alternatives provide cognitions that are dissonant with the cognition that the individual has chosen as he did. To reduce the resulting dissonance pressure, the individual exaggerates the favorable features of the chosen alternative and plays down its unfavorable aspects. This leads him to enhance his rating of the chosen alternative. Similar reasoning predicts that he will lower his rating of the rejected alternatives. These predictions are confirmed in a number of studies. (See Brehm & Cohen, 1962, p. 303; see also Festinger, 1964.)

A number of secondary predictions concerning parameters of the choice have also been confirmed. In an experiment by Brehm and Cohen (1959), school children were permitted to select a toy from either two or four alternatives. Some children chose from qualitatively similar toys; others chose from qualitatively dissimilar alternatives. The children's post-choice ratings of the toys on a set of rating scales were then compared to initial ratings obtained a week before the experiment. The main displacement effect appeared as predicted: chosen toys were displaced in the more favorable direction; rejected toys were generally displaced in the unfavorable direction. In addition, however, the displacement effect was larger when the theory choice was made from the larger number of alternatives. Dissonance predicts that this will be so because with many alternatives "the more one must give up [in choosing only one] and consequently the greater the magnitude of dissonance." Similarly, the displacement effect was larger when the choice was made from dissimilar rather than similar alternatives. According to dissonance theory this is so because with dissimilar alternatives the degree of "cognitive overlap between clusters of cognitive elements" is smaller; what one has to give up relative to what one gave increases and hence, there is more dissonance produced in choosing only one alternative. (Festinger, 1957, p. 41).

To interpret these findings within the framework of self-perception, consider an observer trying to estimate a child's ratings of toys; the observer has not seen the child engage in any behavior with the toys. Now compare this observer with one who has just seen the child select one of the toys as a gift for himself. This comparison parallels respectively the pre-choice and the post-choice ratings made by the children themselves. It seems likely that the latter observer would displace the estimated ratings of the chosen and rejected alternatives further from one another simply because he has some behavioral evidence upon which to base differential ratings of these toys. What about the number of alternatives? If an observer had seen the selected toy "win out" over more competing alternatives, it seems reasonable that he might increase the estimated displacement between the selected and the rejected toys. Finally, what Festinger describes as the results of differential magnitudes of dissonance owing to the degree of cognitive overlap between clusters of cognitive elements corresponding to the alternatives, a behaviorist would be more inclined to call stimulus generalization. That is, to the extent that the chosen and rejected alternatives are similar to one another, they will be rated close together on a scale by any rater, outside observer or the child himself. In sum, if one regards the children as observers of their own choice behavior and their subsequent ratings as inferences from that behavior, the dissonance findings appear to follow. The following demonstration illustrates the point.

An Interpersonal Replication of the Toy Study

Twenty-four college students served as control Ss by estimating how an 11-year old boy might rate several different toys that are "typically popular with this age group." These toys were selected from the list reported by Brehm and Cohen (1959) and were rated on the same rating scales. The toys to be rated in the subsequent experiment were then selected on the basis of these ratings according to the same criteria of selection employed by the original investigators.

For the experiment itself, 96 college students were given a sheet of paper with the following information: "In a psychology experiment, an 11-year old boy was asked to rate how well he liked toys that are typically popular with this age group. He was then permitted to select one of these toys to keep for himself. We are interested in how well college students can estimate his ratings." Each sheet also informed the S which toy the child had chosen and from which alternatives he was permitted to choose. He then made his estimates of the child's ratings. The Ss were randomly assigned to one of four conditions corresponding to the combinations of number of alternatives (2 or 4) and similarity of alternatives (similar or dissimilar).

Results. (1) Effect of choice. Table 4 lists the toys employed, the control group means, and the displacements from those means of the corresponding experimental group means for the chosen and rejected alternatives in each condition. Scores can range from 0 to 5, where a higher number indicates greater liking for the toy; a positive displacement indicates increased liking for the toy. To facilitate comparisons among conditions, the toy rated as most popular by the control group, the swimming snorkel, was employed as the "chosen" toy in all experimental conditions. In addition, it will be noted that it was possible to match closely the combined mean ratings of the rejected alternatives in the 4-alternative conditions; unfortunately this could not be done for the 2-alternative conditions.

Insert Table 4 about here

It is seen in Table 4 that the chosen alternative was rated higher and the rejected alternatives were rated lower than the corresponding control group means in every condition. In both of the 2-alternative conditions, the total displacement effect is significant at the .01 level (t = 3.66 and 2.81 for the similar and dissimilar conditions respectively); for both of the 4-alternative conditions, it is significant at the .001 level (t = 5.26 and 9.18 respectively). It should be noted, however, that some of the downward displacement of the rejected alternatives in the 2-alternative conditions must be attributed to regression effects since the initial means of these alternatives are above the grand mean. This problem has been avoided in the 4-alternative conditions by combining the ratings of the three rejected alternatives; in this case the predicted displacement effect is opposite in direction to that due to regression, as is the upward displacement of the chosen alternative in all four conditions. Thus, the main displacement effect is clearly replicated by interpersonal judgments.

(2) Similarity of alternatives. From simple considerations of stimulus generalization, it was predicted that the displacement effect should be greater in the dissimilar than in the similar conditions. Because of the differential effects of regression, mentioned above, however, our analysis must be confined to the 4-alternative conditions where it was possible to match the control means of the rejected alternatives. Within this condition, the mean total displacement is .70 in the similar condition and 1.25 in the dissimilar condition, a difference significant at the .05 level (t = 2.22). The hypothesis is confirmed.

(3) Number of alternatives. It will be recalled that the present experiment is attempting to replicate the positive relation found between the displacement and the number of alternatives. Again, the displacements of the rejected alternatives in the 2-alternative conditions cannot be legitimately incorporated into the comparison The present analysis, therefore, is confined to the upward displacement of the chosen alternative. For the 4-alternative conditions, the mean upward displacement of the swimming snorkel is seen to be .84; for the 2-alternative conditions, it is .28. This difference between conditions is significant at the .01 level (t = 3.29). The dissonance findings are again replicated by interpersonal observers.

It is suggested that this same kind of functional analysis can be applied to the other studies in this category of dissonance experiments. Once again, it seems uncessary to invoke a motivational construct to account for the data.

Exposure-to-Information Studies

This third major category of dissonance studies includes those which provide the most direct test for a motivational process. If cognitive dissonance is, in fact, an aversive state, then a person should avoid exposure to sources of dissonant information and seek out non-dissonant sources. Compared with the theoretical chain of reasoning behind the forced-compliance and free-choice studies, this deduction from dissonance theory is by far the most direct, the easiest to test, and the most crucial for justifying a motivational construct like dissonance. The available evidence, however, is not supportive. In an extensive review of the relevant studies, most of which were conducted by investigators whose theoretical orientation would lead them to look for selective exposure to non-dissonant information, Freedman and Sears (1965) conclude that "clearly experimental evidence does not demonstrate that there is a general psychological tendency to avoid nonsupportive and to seek out supportive information."

There is, of course, nothing within the behaviorist's functional framework that would rule out a motivational phenomenon. For example, it is not at all implausible to suppose that punishment is often contingent upon being inconsistent, illogical, or just plain wrong in our highly verbal culture. This would be particularly true for the college students who typically serve as Ss in cognitive dissonance experiments. Accordingly, evidence demonstrating that it is aversive for such Ss to maintain incompatible responses in their verbal repertoires might well be forthcoming. Such a phenomenon is appropriately labeled motivational, but it would be the consequence of a particularly common cultural practice and would not, it is suggested, justify the reification of a new internal drive that is assumed to be an inherent characteristic of behaving organisms.

Some Metatheoretical Considerations

In the opening remarks, some contrasts were noted between the conceptual approach typified by dissonance theory and the behavioral approach represented here by the functional analysis of self-perception. It was pointed out that the behaviorist's goal is to account for observed relations between current stimuli and responses in terms of an individual's past history of stimulus events and a small number of basic functional relations discovered in the experimental analysis of simpler behaviors. The behaviorist's functional analysis of complex behaviors like dissonance phenomena was thus seen to be based on empirical generalization, a feature which infuses it with an inductive flavor and spirit.

In contrast, the dissonance theorists clearly prefer the "deductive" nature of their theory and explicitly derogate the "weakness of an empirical generalization as compared with a true theoretical explanation" (Lawrence & Festinger, 1962, p. 17). This criticism of the behaviorist's functional analysis, namely, that it has no deductive fertility or predictive power, is often expressed. The radical behaviorist, so the criticism goes, will not venture a specific prediction without knowing the complete reinforcement history of the organism. He cannot provide a "true theoretical explanation."

It is suggested here, that a functional analysis appears to have limited predictive power only because it makes explicit the kinds of knowledge about the past and present controlling variables that any theorist must have if he is to predict behavior accurately. How, for example, do the dissonance theorists conclude that dissonance is present in a particular case? That is, how do they decide when one cognition does not "follow from" another? According to Festinger, "the vagueness in the conceptual definition of dissonance--namely, two elements are dissonant if, considered alone, the obverse of one follows from the other--lies in the words 'follows from'...One element may follow from another because of logic, because of cultural mores, because of things one has experienced and learned, and perhaps in other senses too" (1957, p. 278). Five years later, Brehm and Cohen note that "the 'follows from' relationship can sometimes be determined empirically but is limited by our abilities to specify and measure cognitions and the relationships among them...the 'follows from' relationship is not always clear and specifiable" (1962, pp. 11-12).

In actual practice, however, the dissonance theorists experience no real difficulty in inferring the existence of dissonance from their stimulus operations. It is not difficult precisely because it is in that inference that the dissonance theorists sneak through the back door the very knowledge they claim to do without. It is in that inference that they implicitly make use of the fact that they have been raised by the same socializing community as their subjects. The dissonance theorists can infer that a $1 compensation will produce more dissonance than a $20 compensation for exactly this reason, just as it has been <u>our</u> common history with these same <u>S</u>s that permits <u>us</u> to speculate that the difference in compensation represents a difference in the mand properties of the induced behavior. Interpersonal observers are successful in replicating dissonance pehnomena for the same reason. Dissonance theorists and radical behaviorists need the same kinds of knowledge. Only the behaviorists, however, take as their explicit obligation the necessity of accounting for both their own and their <u>S</u>s' differential response to such controlling variables.

In sum, it is concluded that the greater "deductive fertility" of dissonance theory is largely illusory. In the process of adequately explicating the phrase "follows from" in their fundamental statement, the dissonance theorists will necessarily have to perform the explicit functional analysis they had hoped to finesse. It remains the behaviorist's conviction that the appeal to hypothetical internal states of the organism for causal explanations of behavior is heuristically undesirable. Such diversion only retards and deflects the thrust of the analysis that is ultimately required.

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2. All significance levels in this article are based on two-tailed tests.

Table 1

Attitude Ratings and Interpersonal Estimates of Attitude Ratings toward the Tasks for Each Condition

		Experimental Condition	
Study	Control	One Dollar Compensation	Twenty Dollar Compensation
Festinger-Carlsmith (N = 20 in each condition)	-0.45	+1.35	-0.05
Interpersonal Replication (N = 25 in each condition)	-1.56	+0.52	-1.96

Table 2

Interpersonal Estimates of

Attitude Ratings toward the Tasks

(N = 25 in each cell)

Experimental Condition	Long Communication	Short Communication
One Dollar Compensation	+0.52	-1.04
Twenty Dollar Compensation	-1.96	-0.64

Table 3

Summary of Analysis of Variance of Interpersonal Estimates of Attitude Ratings toward the Tasks

Source of Variation	Sum of Squares	df	Mean Square	F
Long versus Short	0.360	1	0.360	0.05
$1 versus $20	27.040	1	27.040	4.07*
Interaction	51.840	1	51.840	7.80**
Within cells	637.920	96	6.645	

*p < .05

**p < .01

Table 4

Mean Displacement in Toy Ratings from Control Group Means for

Chosen and Rejected Alternatives in Each Condition

(N = 24 in the control and each experimental condition)

Experimental Condition		Similar Alternatives			Dissimilar Alternatives		
		Toy	Control	Displacement	Toy	Control	Displacement
Two Alternatives	Chosen	Swimming Snorkel	3.45	+.35	Swimming Snorkel	3.45	+.22
	Rejected	Swimming Mask	3.44	-.39	Archery Set	2.79	-.42
Four Alternatives	Chosen	Swimming Snorkel	3.45	+.69	Swimming Snorkel	3.45	+.99
	Rejected	Swimming Mask Swimming Fins Life Jacket	2.54	-.01	Archery Set Bowling Game Ship Model	2.58	-.26

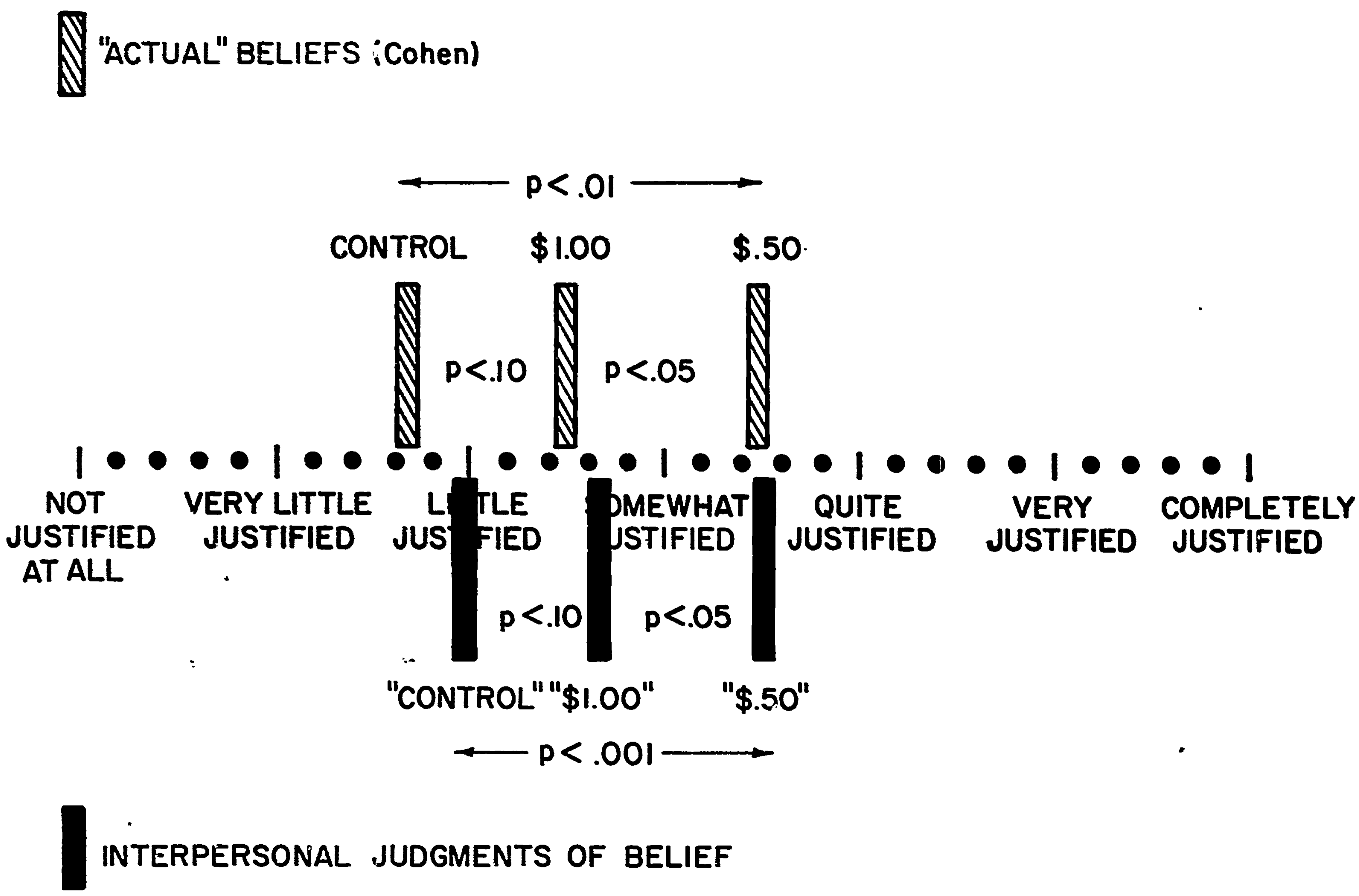

Fig. 1. A comparison of "actual" beliefs and interpersonal judgments of belief.

GROUP B: LANGUAGE ACQUISITION

The child's acquisition of his native language in his first few years is an impressive accomplishment. To understand the process by which such sophisticated habits are acquired will have ramifications beyond the fields of education, psychology, and linguistics where most of the current work in this area is being done. Five studies in the present report have the understanding of this progress as their goal.

Three of the studies deal with comparisons of language functioning in retarded and normal children. The retarded child is an appropriate subject for the study of language acquisition because it is probable that these children go through the same stages in developing language facility but their slower progress permits a more systematic study of the changes which occur. It is hoped that comparisons of the type undertaken in these three studies will improve our understanding of language development in all populations of children.

The final two papers in this section deal with several psychological and linguistic theories and their application to the acquisition of language. From an examination of the language development of children learning English, Japanese, and Russian, David McNeill concludes that a theory which relates the notion of linguistic universals to the notion of an innate capacity for language is the most promising at the present time.

Grammatical Analysis of Word Association Responses of Educable Mentally-Retarded and Normal Children.[1]

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Abstract

A grammatical analysis of free-associate responding was made using retarded (public school and institutionalized) and normal Ss (one group of comparable chronological age and one of equal mental age). The older normal Ss (CA match) gave significantly more associates of the same form class (paradigmatic) than the other three subgroups. The public school retardates and normal group matched with the retarded Ss on MA were rather similar in performance. The institutionalized retardates gave the fewest paradigmatic responses. A significant interaction between subgroups and form classes was found. The data were discussed in terms of two contemporary models: the mediation hypothesis and the development of minimal semantic contrasts.

The nature of language development in mentally retarded children is thought to offer an opportunity to study language processes in "slow motion" (Lenneberg, 1964a, 1964b). Carroll (1963, 1964) and others have indicated that studying the protracted language development of retarded children may lead to a clearer understanding of how grammar develops and how grammatical phenomena are hierarchially organized in conceptual difficulty.

Brown and Berko (1960), Ervin (1961), and others (Entwisle, Forsyth, and Muuse, 1964) have demonstrated that as children grow older there is a progressive change in the form of word association responses. Children tend to move from sequential responses (syntagmatic responses) to associations falling within the same grammatical form-class as the stimulus (paradigmatic responses). This progression from syntagmatic to paradigmatic word associations is suggested as evidence for an increasing grammatical competence in language functioning (Brown & Berko, 1960; Jenkins, 1965; Jenkins & Palermo, 1964).

The incidence of paradigmatic associations also depends on the grammatical form-class of the stimulus words (Deese, 1962). The correlation between form-class of stimuli and paradigmatic responding appears to be reduced however, by an interaction with the chronological age of Ss. Entwisle et al. (1964) reported a convergence toward an equal number of paradigmatic responses to nouns, verbs, and adjectives as the chronological ages of Ss increased. Younger children, on the other hand, give a significantly greater number of paradigmatic responses to nouns when compared to other form-classes.

There appears to be an absence of empirical evidence on the effects of mental age and other organismic variables on the incidence of paradigmatic responding of school age children in word association task. Lenneberg (1964a; 1964b) has recently questioned the purported strong relationship between language functioning and non-specific intelligence. The purpose of the present study was to compare the word association responses of institutionalized and non-institutionalized educable mentally retarded children with normal children of comparable mental or chronological ages. The study sought to determine the relationship of mental retardation to the degree of "grammatical control of stimulus-response relations" in the word association task (see Jenkins, 1965).

Method

Subjects. Table 1 presents the characteristics of the four subgroups used in this study. The institutionalized retarded Ss (I-R) and Public School retarded Ss (PS-R) were randomly selected from a CA range of 10 through 14 years, and IQs from 60 through 80 on individual intelligence tests, and were stratified on the sex and race variables. The normal Ss consisted of one subgroup randomly selected from a mental age range comparable to the retarded samples (MA-N) and a second subgroup selected from the same CA range as the two retarded subgroups (CA-N). There were 20 Ss in each subgroup, all of whom came from fairly low socioeconomic backgrounds.

Table one about here

Selection of Stimuli. Forty stimuli were selected from the Mein and O'Connor (1960) word list. The stimuli appeared among the 500 words used most frequently by retarded children, and were classified as either nouns, verbs, adverbs, adjectives, pronouns, or prepositions. Thirty-eight stimuli had AA frequency on the Thorndike-Lorge general word court, the remaining two stimuli had A frequency. Webster's New Collegiate Dictionary was used to corroborate the assignment of each word to an appropriate grammatical form-class.

Procedure. Stimuli were typed on 5 x 8 unlined index cards. The forty cards were randomized by hand shuffling prior to individual presentation to S.

Each S was introduced to the word-association task as follows:

"We are going to play some word games today. Now if you're ready, I'll tell you the rules for the game."

"In this game I'll show you a word on each one of these cards. I'll say the word to you. The idea of the game is for you to say the first word you think of when I say the word to you. You should say just one word not more than one."

The S was then presented three sample stimuli to assure comprehension of the task. E presented the first sample word by saying:

"Now let's see if you understand the rules of the game - What's the first word you think of when I say 'cow'?"

Any single-word response was reinforced by E with "Good!" or "Fine!" This general procedure was followed in presenting the remaining two sample words (draw and cold). The test stimuli immediately followed S's response to the last sample word.

Coding Responses. Figure 1 presents the model developed for categorizing the word association responses. Three judges working independently first determined if the response was a simple repetition of the stimulus word. If not a repetition, the judge next determined if the response was sequential (i.e., could it appear in an immediately contiguous relationship to the stimulus). Sequential responses were next judged to be either homogeneous (i.e., of the same form-class as the stimulus) or heterogeneous (i.e., of a different form-class from the stimulus). A response categorized as sequential-homogeneous (S-Hm) could occur in contiguous relationship to the stimulus word and was of the same form-class as the stimulus (e.g., stimulus: was; response: gone). A sequential-heterogeneous response (S-Ht) could also appear in contiguous relationship to the stimulus but differed from the stimulus in grammatical form-class (e.g., stimulus: yellow; response: tree).

A response judged non-sequential (i.e., rarely occurring contiguous to the stimulus word) was next judged with regard to form-class. Thus, non-sequential-homogeneous responses (NS-Hm) were those having an extremely low probability of appearing in sequence but were in the same form-class as the stimulus (e.g., stimulus: table; response: chair). The non-sequential-heterogeneous category (NS-Ht) contained non-sequential responses that differed in form-class from the stimulus (e.g., stimulus: red; response: sit).

It should be noted that the NS-Hm category is equivalent to the paradigmatic category used by other researchers (Ervin, 1961; Deese, 1962), whereas the remaining three categories (viz., S-Hm, S-Ht, and NS-Ht) are components of the syntagmatic category.

The judges were three adult native speakers. Inter-judge reliability was estimated using the method described by Ebel (1951). The resulting reliability coefficient was .99. The percentage of agreement between judges within subgroups ranged from 87.9 percent (I-R) to 92.0 percent (CA-N).

Figure 1 about here

Results

Table 2 presents means and standard deviations for the four major response categories across the four subgroups. Figure 2 is a graphic representation of these data.

Table 2 about here

Figure 2 about here

The NS-Hm responses (paradigmatic) were arranged for a two-way repeated measures analysis of variance in which differences between form-classes and subgroups were analyzed. Table 3 summarizes this analysis. The results show a significant interaction between subgroups and form-classes of stimuli. Both main effects of form-class and subgroups were also significant.

Table 3 about here

Table 4 presents a comparison of the mean percentage NS-Hm responses for the four subgroups. The CA-N <u>Ss</u> produced significantly more NS-Hm associations to stimuli than the other three subgroups. The mean differences between the I-R, PS-R and MA-N subgroups were <u>not</u> reliable.

Table 4 about here

Figure 3 presents the mean number of paradigmatic responses to each form-class for the four subgroups.

Figure 3 about here

An analysis of interaction effects (see Figure 3) revealed that the four subgroups did not differ in the number of paradigmatic responses given to nouns and prepositions. Paradigmatic responding to adjectives was not different for the CA-N, PS-R, and MA-N subgroups, but the CA-N Ss did give significantly more NS-Hm responses to these stimuli when compared to the I-R subgroup. The CA-N Ss showed significantly more paradigmatic responses than the other three subgroups to verbs, adverbs, and pronouns. There were no significant differences between the MA-N, I-R or PS-R subgroups with the exception of pronouns where the PS-R and I-R subgroups were different in NS-Hm responding.

An analysis within subgroups revealed that for the CA-N and MA-N subgroups, there were no differences in paradigmatic responding to nouns, verbs, adjectives, pronouns, and adverbs. All of these, however, were significantly higher than prepositions. The differences between paradigmatic responding to the various form classes of stimuli in the PS-R subgroup were between nouns and adverbs, nouns and prepositions, verbs and prepositions, adjectives and prepositions, and pronouns and prepositions.

The I-R subgroup gave significantly more paradigmatic responses to nouns than to any other form class; NS-Hm responding did not differ within the remaining five form classes.

Since the NS-Ht, S-Hm and S-Ht responses have in effect been categorized in previous research as syntagmatic (Deese, 1962), these categories were pooled to obtain a comparable dichotomy between paradigmatic and syntagmatic associations. Figure 4 is a histogram showing the mean percentage of each category produced by each of the four subgroups. The greatest discrepancy between categories was revealed by the I-R subgroup, while the smallest difference is reflected in the CA-N subgroup. The MA-N and PS-R subgroups were approximately equal in the discrepancy between paradigmatic and syntagmatic responding.

Figure 4 about here

An analysis of variance was used to compare males and females on mean percentage of NS-Hm reponses. Females responded with significantly more NS-Hm associations than males (F=14.86/ df 1,72/ p < .01). The main effects were, however, qualified by a significant interaction of subgroups by sex (F= 5.70/df 3,72/p < .01). Figure 5 graphically presents the comparisons of simple effects. Only the MA-N subgroup revealed <u>no</u> significant difference between males and females.

Figure 5 about here

A simple analysis of variance was conducted to determine the reliability of differences between Negro and Caucasian <u>S</u>s on mean percent NS-Hm responses. The resulting F ratio was not significant (F= .91/df 1,78/p > .05).

Type-Token Ratios (TTR's) were calculated for each <u>S</u> by dividing the number of different word responses by the total number of responses to the 40 stimuli. Table 5 presents the mean TTR's for the four subgroups and the correlations between NS-Hm responses and TTRs. An analysis of variance did not confirm significant differences between subgroup mean TTR's ($F = .22/df\ 3, 76/ p > .05$).

Table 5 about here

Discussion

The results of the present study reconfirmed that increasing age of children is accompanied by a shift from primarily sequential associations to responses of the same grammatical form-class. Young normal children produced significantly more syntagmatic and fewer paradigmatic word associations than older normal children. These results, however, also directly implicate intellectual level as a significant variable in the shift to associations of the same grammatical form-class. While the public school retarded children in this study were the same age as the CA-N group, they produced significantly fewer paradigmatic responses. However, the PS-R Ss did not differ from the younger normal children who had comparable mental ages. Hence, it would appear that IQ as well as chronological age plays a significant role in determining the extent of grammatical mediation of S-R relations in word association situations (Jenkins, 1965). The results imply that, with respect to the public school educable retarded child, Carroll (1964) Lenneberg (1964a, 1964b) and others may be correct in assuming that such children undergo a "slow motion" language development.

Variability of responses as reflected through TTR's showed a moderately high relationship to the incidence of paradigmatic responses within each subgroup. The TTR's did not differ significantly between subgroups. The relatively high TTR's indicate a low level of redundancy for all subgroups. Therefore, it is unlikely that differences in verbal perseveration could account for the differences observed between groups in the number of paradigmatic responses emitted.

The sex variable is complex. The data suggest that in six to ten-year-old children (MA-N) sex is <u>not</u> an important variable in the grammatical control of word association responses. However, retarded and older normal female <u>S</u>s give significantly more paradigmatic responses than males by ages 10 to approximately 14 years. Thus, as in other areas of language development, older females performed at a higher developmental level than males (McCarthy, 1954; Sirkin & Lyons, 1941; Goda & Griffith, 1962).

The significant interaction between form-class and subgroups suggests that intelligence level and CA may affect the hierarchy in paradigmatic associations to specific grammatical form-classes. The reported (Entwisle, et al., 1964) convergence toward an equal number of paradigmatic responses to nouns, verbs, and adjectives as the CA of normal children increases was only partially evidenced in these data. The I-R subgroup revealed significantly more paradigmatic responses to nouns than any other form-class. However, all subgroups tend to produce relatively few paradigmatic responses to prepositions. Since prepositions have been classified as function words (Fries, 1952), the data suggest differential paradigmatic responding to content and function words.

Recently, McNeill (1965) has suggested that the paradigmatic shift described by previous researchers may in fact <u>not</u> constitute a change in grammatical form-class usage. McNeill reminds us that, "The child's acquisition of syntax begins sometime around the second birthday...and is largely complete by age three and a half or four. Thus, the implicit grammatical rules which we suppose to form the basic 'motor' for paradigmatic association, are mastered by children at least three years before they show the paradigmatic shift (p.33)."

McNeill contends that paradigmatic responses consist of minimal contrasts between "dictionary entries," i.e., possibly because a child hears words used in many different contexts, he learns more and more features of these words. The more semantic "markers" applied to words by the child, the more likely that word associations will be of the same form-class as the stimulus words.

Our data generally demonstrate fewer paradigmatic responses to prepositions and most to nouns. Since prepositions are considered to serve a primarily syntactic role in language, they would be expected to have fewer semantic features when compared to nouns, which bear a primary function for conveying meaning. Hence, children would be expected to acquire more semantic features to nouns than to prepositions, and to give a greater number of paradigmatic associates to the latter than to the former. The semantic model posited by McNeill would, then, appear to gain support from the present findings.

The present authors propose that future research should be directed toward simultaneous testing of both the semantic and syntactic variables associated with the hypothesized syntagmatic-paradigmatic shift. Another line of research would be to differentiate between <u>competence</u> and <u>performance</u>. In particular we are concerned about the effect of the <u>S</u>'s set antecedent to the word-association task (See Carroll, 1964). A design allowing both a base line measure of paradigmatic responding and a subsequent task that assesses the ability to give paradigmatic associations after selective reinforcement of these responses would add to our knowledge of the question of competence versus performance. This is the direction of our future research.

Summary

A grammatical analysis of free-associate responding in retarded and normal children was made. Twenty institutionalized retardates (I-R) and 20 retarded children from special public school classes (PS-R) were matched with a group of 20 normal children of the same chronological age (CA-N). A fourth group (MA-N) consisted of 20 normal children matched on mental age with the retarded subgroups. Responses were judged by three coders on the basis of: a) whether the response could appear in an immediately contiguous position to the stimulus word; and b) whether the response word was of predominately the same form class as the stimulus.

The CA-N subgroup gave significantly more associates of the same form class (paradigmatic) than the other three subgroups. The PS-R and MA-N subgroups were rather similar in their performance; the institutionalized retardates (I-R) gave the fewest paradigmatic responses. A significant interaction between subgroups and form classes was found. These effects were analyzed and discussed.

In the I-R, PS-R, and CA-N subgroups, females gave significantly more paradigmatic responses than males. Males and females within the MA-N subgroup did not differ in the number of paradigmatic responses given. The subgroup differences in paradigmatic responses do not appear to be a function of the number of different response words given by the Ss. The data were discussed in the context of two contemporary models: the mediation hypothesis (Jenkins, 1965) and the development of minimal semantic contrasts (McNeill, 1965).

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Table 1

Characteristics of the Four Subgroups

(N=20 each subgroup)

Variable		Subgroup			
		I-R*	PS-R*	MA-N*	CA-N*
CA (Months)	Mean	141.15	141.65	97.00	140.30
	SD	14.01	13.03	12.96	11.95
	Range	120-164	120-160	76-123	123-165
MA (Months)	Mean	98.95	98.00	98.55	143.15
	SD	12.80	10.34	13.30	12.65
	Range	82-128	77-117	75-127	119-161
IQ	Mean	70.15	69.60	102.25	102.30
	SD	5.34	5.79	6.34	8.56
	Range	61-78	60-80	90-118	92-126
Sex	Males	9	10	10	10
	Females	11	10	10	10

*Each subgroup consisted of 12 Caucasian and 8 Negro Ss.

Table 2

Mean Percent Responses within Categories

Across the Four Subgroups

(N=20 each subgroup)

Subgroups		Paradigmatic	Syntagmatic		
		NS-Hm	NS-Ht	S-Hm	S-Ht
CA-N	Mean %	48.14	7.19	2.21	42.29
	SD	15.60	4.33	1.65	16.19
MA-N	Mean %	30.91	13.30	1.84	53.82
	SD	18.60	6.74	1.67	20.44
PS-R	Mean %	28.54	13.39	1.49	56.43
	SD	16.97	5.18	1.64	17.59
I-R	Mean %	21.57	12.51	1.65	64.02
	SD	17.77	8.82	1.47	19.02

Category Abbreviations:

NS-Hm -- Non-Sequential Homogeneous

NS-Ht -- Non-Sequential Heterogeneous

S-Hm -- Sequential Homogeneous

S-Ht -- Sequential Heterogeneous

Subgroup Abbreviations:

CA-N -- Equal CA normal Ss

MA-N -- Equal MA normal Ss

PS-R -- Public School retarded Ss

I-R -- Institutionalized retarded Ss

Table 3

Summary of Analysis of Variance for

Subgroups and Form-Class of Stimuli[1]

Source	SS	df	MS	F
Between Ss	162314.40	79		
A (Subgroups)	47209.33	3	15736.44	10.39 **
Subjects within gps.	115115.07	76	1514.67	
Within Ss	184618.57	400		
B (Form Class)	56320.36	5	11264.07	37.35 **
A x B	13684.22	15	912.28	3.02 **
B x Subjects within gps.	114613.99	380	301.62	

** Sig. at less than .01 level

[1]A simple analysis of variance model was used in a preliminary summary (Progress Report #1 CRLLB) of the data in Table 3. The repeated measurements design used above is more appropriate and accounts for the discrepancy between the significance of the A x B interaction reported here and in the earlier report.

Table 4

Critical Differences between Mean

Percentage NS-Hm Responses for

Subgroups

	CA Normal (CA-N)	MA Normal (MA-N)	Pub. Sch. Ret. (PS-R)	Inst. Ret. (I-R)
Mean %	48.14	30.91	28.54	21.57
MA-N	17.23**			
PS-R	19.60**	2.37		
I-R	26.57**	9.34	6.97	

*Critical difference 13.24 significant at <.01 level.

**Critical difference 16.08 significant at <.01 level.

Table 5

Mean TTR's and Correlations for Subgroups

	CA-N	MA-N	PS-R	I-R	Total
Mean	.86	.85	.83	.85	
SD	.11	.11	.01	.13	
r (NS-Hm and TTR)	.63	.46	.49	.44	.52

Differences between subgroup _r_'s not significant ($p > .05$)

Figure Captions

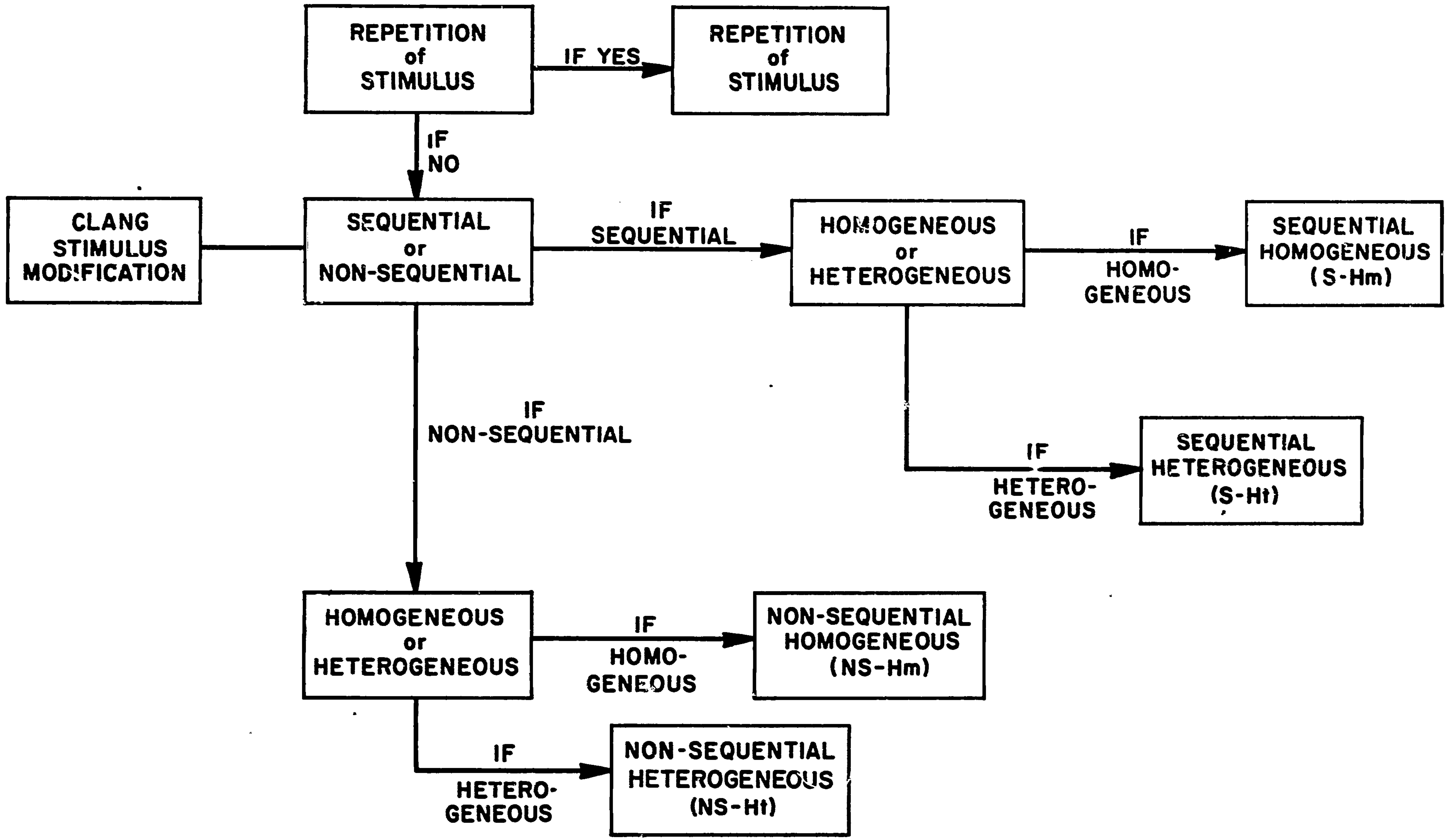
Fig. 1. Stages in the prescribed routine for assigning word associations by the Ss to formal categories.

Fig. 2. The percent of all word associations, emitted by the 20 Ss in each of the four groups, that were assigned to each of the following categories: Sequential-Homogeneous (S-Hm), Sequential-Heterogeneous (S-Ht), Non-sequential Homogeneous (MS-Hm), Non-sequential Heterogeneous (NS-Ht). Retarded Ss in public schools (PS-R) and in institutions (I-R), as well as normal Ss with comparable chronological age (CA-N) or mental age (MA-N) were employed.

Fig. 3. Percent paradigmatic responses by form class for subgroups.

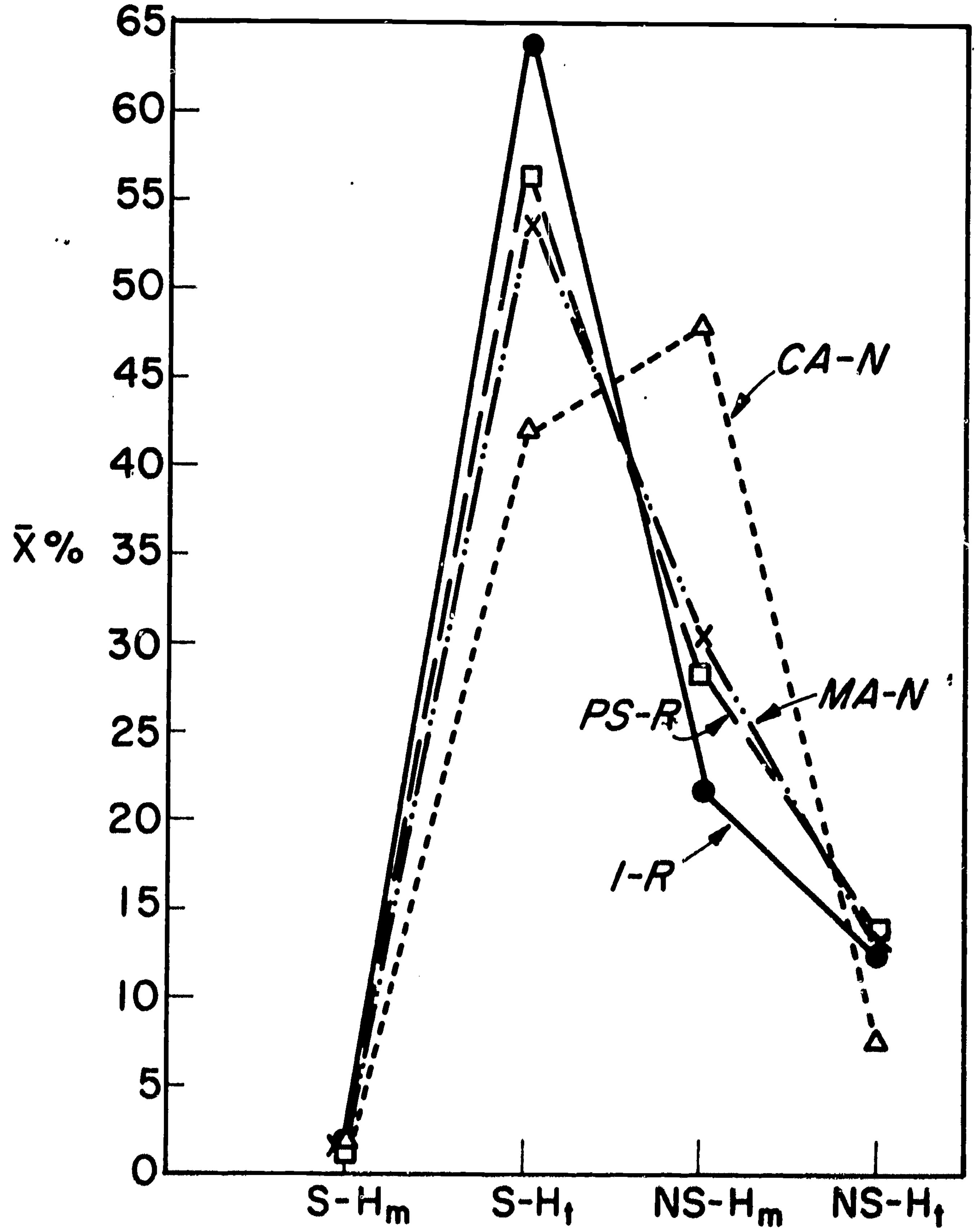
Fig. 4. The percent of syntagmatic and paradigmatic word associations given by the 20 Ss in each of the four subgroups.

Fig. 5. Difference between male and female Ss across the four subgroups on frequency of paradigmatic responses.



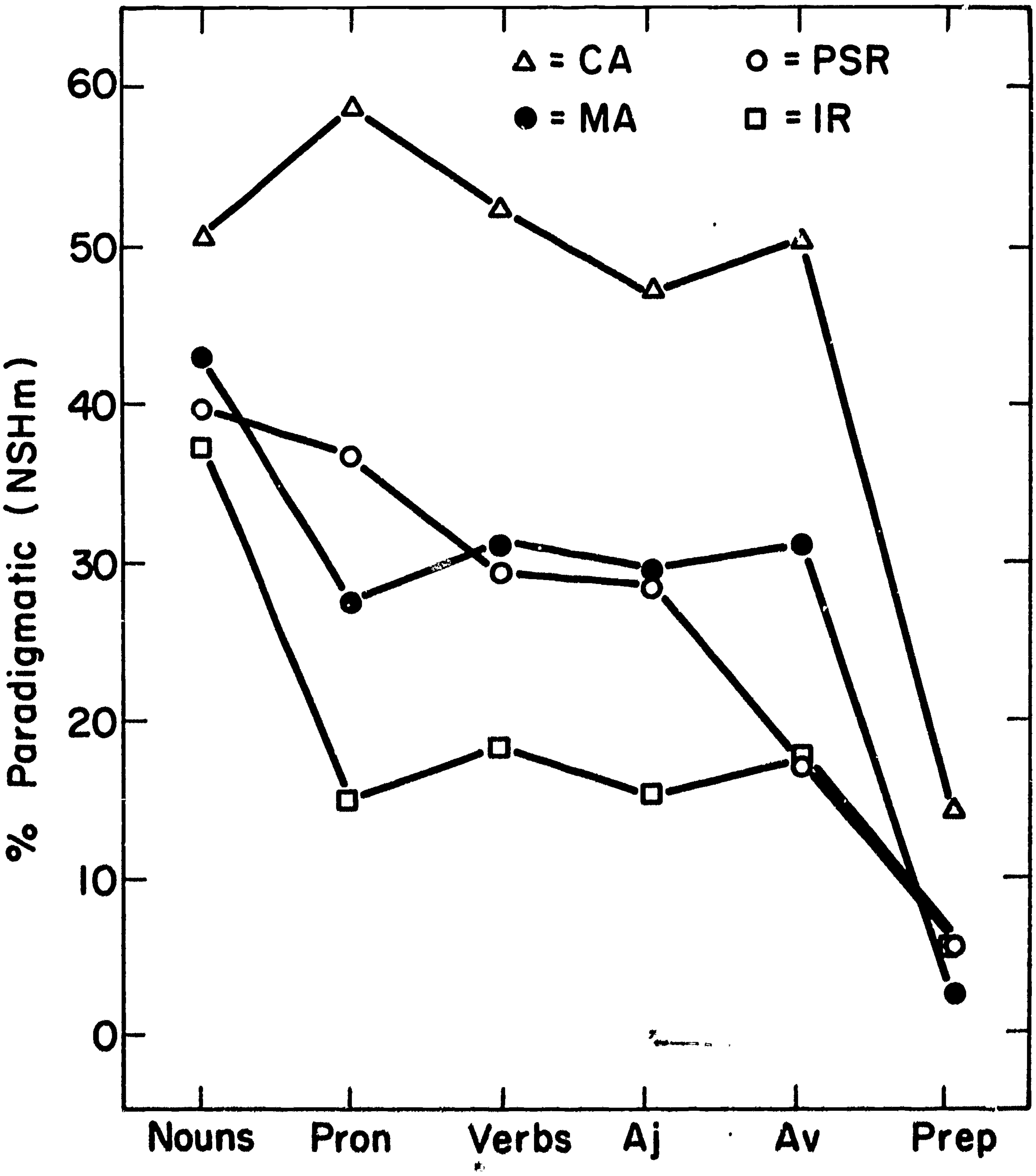
REPETITION of STIMULUS
IF YES
REPETITION of STIMULUS
IF NO
CLANG STIMULUS MODIFICATION
SEQUENTIAL or NON-SEQUENTIAL
IF SEQUENTIAL
HOMOGENEOUS or HETEROGENEOUS
IF HOMOGENEOUS
SEQUENTIAL HOMOGENEOUS (S-Hm)
IF HETEROGENEOUS
SEQUENTIAL HETEROGENEOUS (S-Ht)
IF NON-SEQUENTIAL
HOMOGENEOUS or HETEROGENEOUS
IF HOMOGENEOUS
NON-SEQUENTIAL HOMOGENEOUS (NS-Hm)
IF HETEROGENEOUS
NON-SEQUENTIAL HETEROGENEOUS (NS-Ht)

Fig. 1



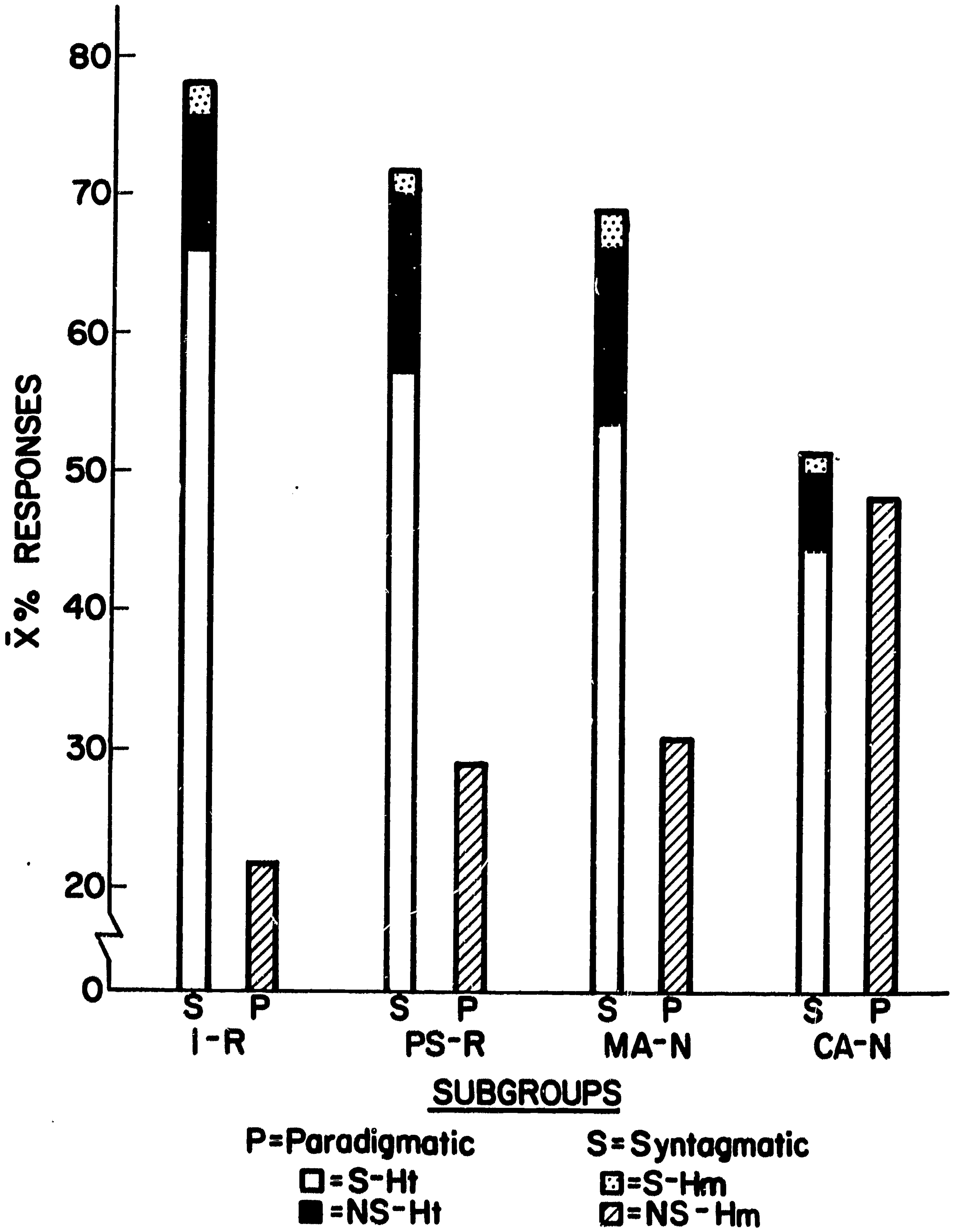
65
60
55
50
45
40
X̄ %
35
30
25
20
15
10
5
0
S-Hm
S-Ht
NS-Hm
NS-Ht
CA-N
MA-N
PS-R
I-R

Fig. 2



△ = CA
○ = PSR
● = MA
□ = IR
60
50
40
30
20
10
0
% Paradigmatic (NSHm)
Nouns
Pron
Verbs
Aj
Av
Prep

Fig. 3



80
70
60
50
40
30
20
0
X̄% RESPONSES
S
P
I-R
PS-R
MA-N
CA-N
SUBGROUPS
P=Paradigmatic
S=Syntagmatic
=S-Ht
=NS-Ht
=S-Hm
=NS-Hm

Fig. 4

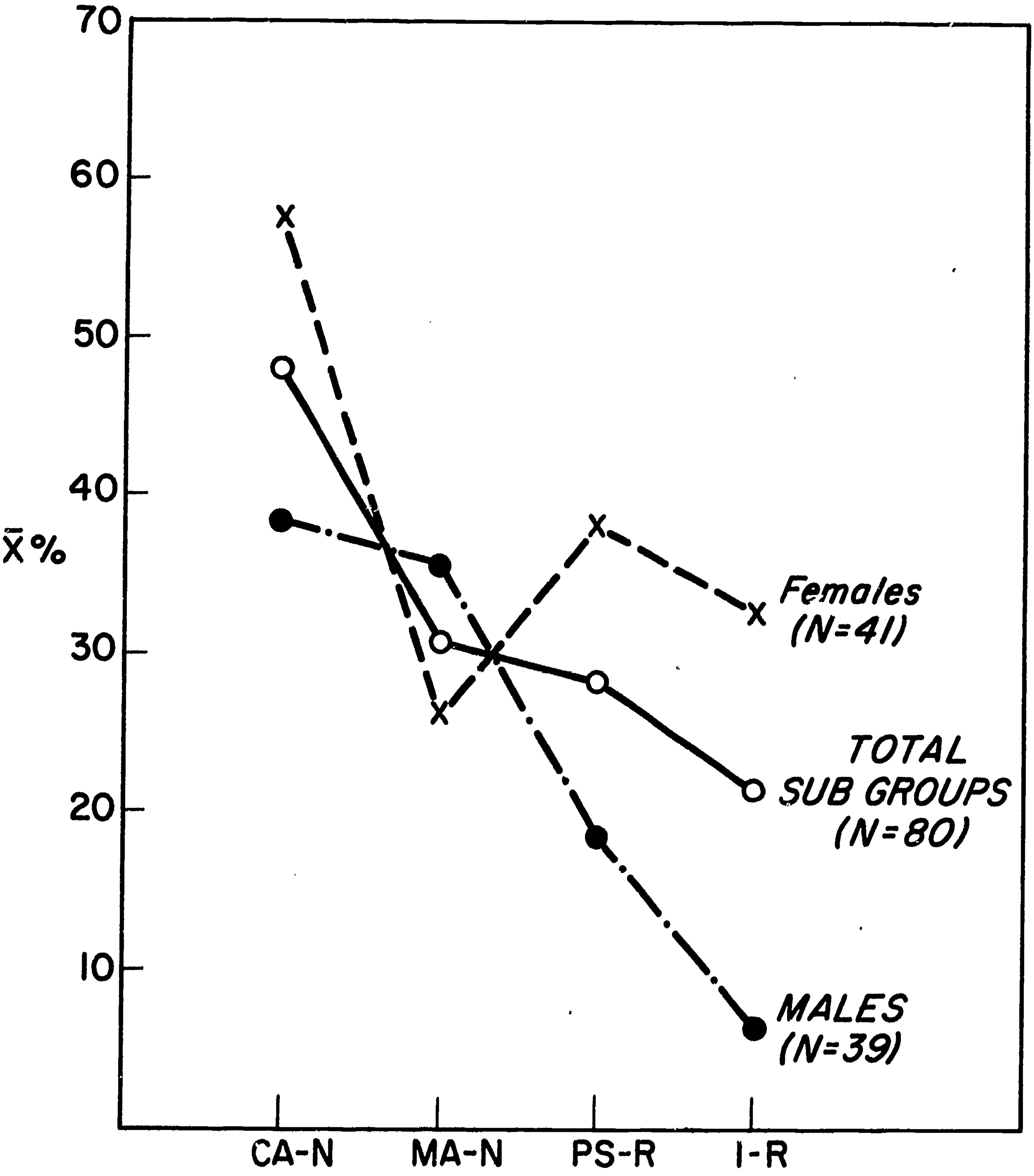

70
60
50
40
30
20
10
X̄ %
Females
(N=41)
TOTAL
SUB GROUPS
(N=80)
MALES
(N=39)
CA-N
MA-N
PS-R
I-R

Fig. 5

Intentional and Incidental Learning in

Normal, Borderline, and Retarded Children

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Abstract

Intentional and incidental learning of retarded, borderline, and normal children was studied using the paradigm described by Bahrick (1959). The higher IQ groups required significantly fewer trials to criterion than the retarded Ss on the intentional learning task. No significant differences were found between group means for the incidental task. A second group of normal Ss (NO_2 group) was matched with the retarded Ss on the number of stimulus exposures experienced by the retarded Ss on the intentional task. The NO_2 group revealed significantly fewer recognition errors on the incidental task when compared to mean errors for the retarded group.

The results of previous experiments comparing intentional and incidental learning of children differing in intellectual ability have been equivocal. Goldstein and Kass (1961) reported that retardates were less accurate in recalling details of previously observed complex stimuli than gifted children of the same age. This result, however, may have been due to the greater verbal ability of the gifted children, who could describe the stimuli more accurately during the recall test. Since the free recall method permits differences in verbal ability between groups to confound results, recent experimenters have preferred matching or recognition tests to assess incidental learning.

Baumeister (1962) tested subgroups of normal and retarded children of the same CA with either an "intentional" or an "incidental" set of instructions and found that retarded children were inferior to normal children in both conditions. Baumeister's results are in agreement with those of Plenderleith and Postman (1956), who found that intentional and incidental learning scores of college students were significantly correlated. On the otherhand, Hetherington and

Banta (1962) tested groups of organic retardates, familial retardates, and normal Ss of the same MA and found no significant correlations between intentional and incidental learning or retention. Thus, for children of the same MA level, intentional and incidental learning processes appear to be independent.

The lack of agreement between Baumeister's and Hetherington and Banta's results may not be due entirely to the different procedures used in matching their respective groups. Hetherington and Banta tested each S first for incidental learning and later for intentional learning, whereas Baumeister tested subgroups of normal and retarded children under one or the other learning condition.

The present study examined the relationship between intentional and incidental learning in normal, borderline and mentally retarded children of the same CA. The experimental design used is that described by Bahrick (1954) in which each S is tested for both intentional and incidental learning using the same stimulus display. Each S was first given training on a serial learning task in which a particular cue was relevant (form); then the S was tested for recognition on another cue (color) which was present in the stimulus but was incidental to the serial learning task.

Method

Subjects. Four groups of 20 Ss each were selected at random from population with CA's between ten and eleven years. Two normal (NO_1 and NO_2) groups had IQ's between 101 and 110 and were enrolled in the University School at Ann Arbor, Michigan. The remaining two groups were selected from residents at the Wayne County Training School. The Borderline (BO) group consisted of Ss with IQs ranging from 76 to 100 (mean IQ=85, SD=5.41).

The Mentally Retarded (MR) group was composed of children with IQs ranging from 50 to 75 (mean IQ=61, SD=4.89).

Apparatus. Drawings of six common objects were used as test stimuli in this experiment. The stimuli included: a cup, a chair, a wagon, a boat, a house, and an umbrella. Each picture was drawn in black ink on a transparent Radio-Mat slide and mounted with a piece of colored filter paper in a 35 mm slide frame. No two pictures were mounted with filter paper of the same color, and careful attention was given to assure that colors were not related to the pictures in any meaningful way. The colors used were red, blue, green, purple, orange, and yellow. These slides were serially presented by means of a slide projector focused on a portable movie screen. The image projected on the screen was 18 x 30 in. The rate of presentation of the slides was controlled by an automatic timer.

Procedure. The Ss were individually tested under identical experimental conditions. After being seated in front of the screen, S was told, "I am going to show you some pictures on the screen, and I want you to tell me what they are." S was then shown all six slides at a rate of one every five seconds. The interslide interval was approximately .7 sec. As each slide was presented, S was asked, "What's this?", and his response was recorded. The verbal responses given by each S on the first trial were used as the appropriate set of responses for all subsequent trials. Thus, if S responded to the picture of the cup with verbal response, "glass", then "glass" was taken as the appropriate response in subsequent trials.

The method of serial anticipation was explained to S through the following instructions: "Now I'm going to show you the same pictures in the same order that you saw them before; only this time I want you to tell me what picture you think is coming up next." The first picture was then projected on the screen, and S was asked, "Do you remember what picture comes after this one?" S was encouraged to guess if he did not give a response immediately. As before, the slides were presented at a rate of one every five seconds on all trials. Each slide presentation was followed by E's question, "and what comes after this one?"

With the exception of the NO_2 group, all Ss were given repeated presentations of the stimuli in the same order until a criterion of two consecutive correct trials was reached. Then, the Ss in the NO_2 group were individually matched with Ss in the MR group for the number of trials they received. Thus, the performance on the serial learning (intentional) task could not be evaluated for this group because the learning criterion was not in effect. However, because this group had the same number of exposures to the stimuli as did the MR group, comparison could be made relative to their incidental learning while controlling for the number of exposures to stimuli. Mention of color was carefully avoided in order to exclude alerting S to the incidental cues in the serial learning task.

Immediately following the serial learning task, all Ss were tested for incidental learning of the background colors of the slides. Slides that were exact replicas of the pictures, without the color backgrounds, were presented to Ss. The E asked S to indicate the color patch that "goes with the picture." Six color patches were placed in front of S who pointed to the appropriate patch after each picture (without color background) was projected on the screen. The S was given as much time as needed to select the color background patch which corresponded to the projected picture on the screen.

Results and Discussion

A simple analysis of variance indicated significantly fewer numbers of trials were required for the higher IQ groups to reach criterion ($F = 18.24$;

df. 2/57; $p<.001$) on the intentional serial learning task. The mean number of trials to criterion was 6.80 (SD = 2.35) for the MR group, 2.95 (SD = 2.10) for the BO group, and 1.20 (SD = 1.02) for the NO_1 group.

The mean number of errors in the recognition of colors (the incidental learning task) was 2.70 (SD = 1.81) for the MR group, 2.65 (SD = 1.85) for the BO group, and 2.15 (SD = 1.92) for the NO_1 group. A t-test revealed that the difference between the mean number of errors in recognition of colors for the MR and NO_1 was not statistically significant ($t = .94$; df. 1/38; $p>.05$). This lack of a significant difference was expected since the retarded group required over five times as many trials as the normal group, and therefore, had considerably more exposures to the incidental stimuli. Hence, in order to make a more adequate comparison of incidental learning in the normal and retarded Ss, the mean number of errors on the incidental task was obtained for the NO_2 group. It is recalled that the NO_2 Ss were individually matched with the Ss in the MR group so they would receive an equal number of exposures to stimuli. The mean number of errors was .80 (SD = .67) for the NO_2 group, as compared to 2.70 (SD = 1.81) for the MR group. The difference between these means was significant ($t = 3.83$; df. 1/38; $p<.001$), indicating that under conditions of equal stimulus exposure normal Ss show greater recognition of incidental stimuli than retardates of the same CA.

The relationship between intentional and incidental learning obtained in the present study agrees with the results of Baumeister (1962) and Plenderleith and Postman (1956) who also tested Ss of approximately the same CA. On the other hand, our data do not support those obtained by Hetherington and Banta (1962), who matched Ss on the basis of MA rather than CA.

The MR group in this study was inferior in both intentional and incidental learning when the amount of stimulus exposure was controlled. Recently, Denny (1964) has hypothesized that retardates may show a deficit in incidental learning because they have "weak internal learning sets". Hence, he contends that retarded children may require special direction and additional motivation since they lack a natural set to learn. The results of this study tend to support Denny's hypothesis. The results also suggest that retarded Ss apparently can achieve normal levels of incidental learning if they are given sufficient exposures to the stimulus material containing the incidental cues. This hypothesis is confirmed by the similar performance of the MR and the NO_1 groups in recognizing colors. In addition to the frequency of exposures to relevant stimuli, variables such as difficulty of the task, amount of incentive, and degree of arousal, probably interact to influence incidental learning of mentally retarded children.

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Serial Position Errors of Educable Retarded,

Borderline, and Normal Children of Equal Chronological Ages

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Abstract

The McCrary-Hunter hypothesis of invariance of relative position curves in serial learning was tested, using groups classified as mentally retarded (MR), borderline (BO), or normal (NO). Pictures of common objects served as stimuli. Results indicated significantly fewer trials to criterion for higher IQ groups. The degree of "bowness" in the error curves was more pronounced for higher IQ groups. However, while position errors were approximately equal during initial trials for retarded Ss, the relative position curve for later trials approximated the NO and BO curves. The results are interpreted as reflecting attentional deficits in retardates during initial trials of the serial task.

McCrary and Hunter (1963) expressed the mean errors committed at each position on a serial verbal learning task as a percentage of the total errors made by Ss. The curves of position-difficulty were nearly identical for groups of slow and fast learners. Thus, they hypothesized that the form of the error-position curve (an inverted U) is an invariant property of serial verbal learning, regardless of the learning ability of Ss.

Contrary to the McCrary-Hunter hypothesis of invariance, Noble and Fuchs (1959) reported that fast learners made relatively more errors in the middle of the list than did slow learners. McManis (1965), however, noted a procedural error in the Noble and Fuchs study. He claimed that had the investigators given their Ss more trials, permitting the slow learners to begin making correct responses, similar curves for the two groups would probably have resulted. It has also been noted that the Noble and Fuchs' calculation of the main effect of learning-ability groups contains a statistical error, which, however, did not critically affect the results.

Several studies have examined the McCrary-Hunter hypothesis with groups of slow and fast learners who have been classified according to measured intelligence. Girardeau and Ellis (1964) studied retarded (mean IQ 66.0) and normal children (mean IQ 99.6) in an experiment on serial learning and found no significant differences in their relative position error curves. Following a similar research strategy, McManis (1965) compared the middle position error percentages for normal (mean IQ 105) and retarded Ss (mean IQ 71) and found no significant differences between groups.

The present study compared educable retardates, borderline retardates, and normal children of the same chronological age on a serial learning task employing pictorial, rather than verbal, stimuli. Thus, the applicability of the McCrary-Hunter hypothesis was tested using Ss of various levels of intelligence and a type of stimulus material not utilized in previous investigations.

Method

Subjects. Three groups of 20 Ss each were selected at random from populations with a CA between ten and eleven years. The normal (NO) group consisted of children enrolled in the University School at Ann Arbor. All Ss in the NO group had IQ's between 101 and 110 (mean IQ=104.2; SD=2.91). The remaining two groups were selected from the Wayne County Training School. The borderline (BO) group consisted of Ss with individual intelligence scores ranging from 76 to 100 (mean IQ=85; SD=5.41). The mentally-retarded group (MR) was composed of children with individual intelligence scores from IQ 50 to 75 (mean IQ 61; SD=4.89). It is noted that both the BO and MR groups were residents of the Training School.

Apparatus. Drawings of six common objects were used as test stimuli in this experiment. The picture stimuli were: a cup, a chair, a wagon, a boat, a house, and an umbrella. Each picture was drawn in black ink on a transparent Radio-Mat slide and mounted with a piece of colored filter paper in a 35mm slide frame. No two pictures were mounted with filter paper of the same color, and careful attention was given to assure that colors were not related to the pictures in any meaningful way. The colors used were red, blue, green, purple, orange, and yellow. These slides were serially presented by means of a Carousel Slide Projector focused on a portable movie screen. The image projected on the screen was 18 x 30 in. The rate of presentation of the slides was controlled by an automatic timer.

Procedure. The Ss were individually tested under identical experimental conditions. After being seated in front of the screen, S was told, "I am going to show you some pictures on the screen, and I want you to tell me what they are." S was then shown all six slides at a rate of one every five seconds. The interslide interval of the Carousel Projector was approximately .7 sec. As each slide was presented, S was asked, "What's this?," and his response was recorded. The verbal responses given by each S on the first trial were used as the appropriate set of responses for all subsequent trials. Thus, if S responded to the picture of the cup with verbal response, "glass," then "glass" was taken as the appropriate response in subsequent trials.

The method of serial anticipation was explained to S through the following instructions: "Now I'm going to show you the same pictures in the same order that you saw them before; only this time I want you to tell me what picture you think is coming up next." The first picture was then projected on the screen, and S was asked, "Do you remember what picture comes after this one?" S was encouraged to guess if he did not give a response immediately.

As before, the slides were presented at a rate of one every five sec. on all trials. Each slide presentation was followed by E's question, "and what comes after this one?"

All Ss were given repeated presentations of the stimuli in the same order until a criterion of two consecutive correct trials was reached.

Results and Discussion

A simple analysis of variance indicated significantly fewer number of trials to criterion for the higher IQ groups ($F=18.24$; df 2/57; $p < .001$). The mean number of trials to criterion was 6.80 ($SD=2.35$) for the MR group, 2.95 ($SD=2.10$) for the BO group, and 1.20 ($SD=1.02$) for the NO group.

Figure 1 shows the number of errors at each of the original positions as a percentage of the total number of errors made during all the learning trials for each group. Although there were six stimuli presented, the Ss were not required to anticipate the first one; and therefore, there are only five original positions indicated on the absissa of the figure. The results of a two-way analysis of variance performed on the relative number of errors at each position for all three groups indicated a significant effect with regard to the percentage of errors made at the various serial positions ($F=8.25$; df 4/228; $p < .01$). A more critical result, with respect to testing the McCrary-Hunter hypothesis, is the degree of bowness of the error position curve, seen in Fig. 1, which is more pronounced for the high IQ groups. This interaction between intelligence groups and serial position was statistically significant at the .05 level ($F=2.04$; df 8/288). Therefore, the results do not support the McCrary-Hunter hypothesis, since a significant interaction was observed with systematic and progressive changes in the form of the error curves as a function of the level of intelligence. It should be noted, however, that

McCrary and Hunter formulated their hypothesis on the basis of data concerned with serial learning of verbal material, whereas the present experimenters used pictorial stimuli. It remains to be determined whether or not the McCrary-Hunter hypothesis is restricted to only serial learning of verbal stimuli.

Insert Figure 1 about here

Both Lepley (1932) and Hull (1935) contended that the typical bow-shaped curve for serial learning could be interpreted as reflecting the effects of forward and backward associations. The interfering traces of these remote associations were thought to produce the characteristic shape of the error distribution. Recently, Ellis (1964) advanced the notion that behavioral differences between normal and retarded children can be explained by "an impoverished stimulus trace" in the subnormal organism resulting from a pathological condition of the central nervous system. This hypothesis, in conjunction with the theorizing of Lepley and Hull, leads to the prediction that items presented near the middle of a serial list would be relatively more difficult for rapid learners than for retarded children. It appears that the data obtained in the present study support this prediction.

A critical variable, noted previously by McManis (1965), that influences the shape of the distribution of relative errors for fast and slow learners, is the amount of training or trials given to the Ss. In general, studies that included little training for Ss have reported significant differences in the relative-error curves between these groups, whereas the opposite has been found for studies employing considerable training. Presumably, an increase in the number of training trials allows the slow learners to make more correct responses, and the shape of their relative-error curve begins to approximate that of the fast learners. This line of reasoning suggested that the relative-error curve of the MR group (slow learners) in the present study should be examined during the course of training trials.

A maximum of three trials was required for all Ss of the NO group to reach criterion. Therefore, it was decided to compare the relative error curve of normal Ss, seen in Fig. 1, with the curve generated by the MR group during its initial three trials. The relative-error curve of the MR group during its subsequent three trials (trials 4-6) was also computed to enable further comparisions to be made. Both curves obtained from the MR group appear in Fig. 2. At the end of the three trials, seven of the twenty Ss in the MR group had attained criterion. Thus, the error distribution for trials 4-6 was obtained from the remaining thirteen retarded Ss. A two-way analysis of variance on the relative errors per position for the NO and MR groups for trials 1-3 yielded a significant group X position interaction ($F=3.12$; df 4/152; $p < .05$). Hence, during the initial training trials the error curve was considerably flatter for the retardates. However, from Fig. 2 it can be seen that during trials 4-6 the retardates showed a striking increase in the percentage of errors made at the middle position. A (Kolmogrov-Smirnov) two-sample test, which is sensitive to any differences in central tendency, indicated that the difference in shape between the two curves shown in Fig. 2 is statistically significant ($\chi^2=11.91$; df 2; $p < .01$). Furthermore, the curve generated by the retardates on trials 4-6 is bowed to the same degree as the curve obtained by the normals during their final three trials.

Insert Figure 2 about here

The data for the MR group suggest that the distribution of errors for retardates changes greatly during the course of training. Initially the curve is fairly flat, whereas with additional trials and improved performance, the curve resembles the inverted U-shaped function typically demonstrated by normal Ss on serial learning tasks. The initial period of poor performance, with errors made randomly across all serial positions, probably reflects the retardate's inability to attend to the critical stimuli. Several studies have found that retardates are particularly slow in learning visual discriminations, and have attributed this effect to an attentional deficit (Stevenson & Iscoe, 1955; House & Zeaman, 1958; Zeaman & House, 1963). Apparently, after most of the retarded Ss had several trials (see curve for trials 4-6 in Fig. 2) they began to attend to the significant stimuli and performed similar to the normal Ss, as reflected in the distribution of errors.

In view of the above findings, the present investigators believe that the McCrary-Hunter hypothesis of invariance may be validly tested only in situations where extended training has been given. Under these conditions the initial differences between the error curves of normal and retarded Ss tend to be reduced with repeated trials during which the retardates become more attentive. The differences in attentional factors between normal and retarded children during serial learning tasks certainly merit further investigation.

Summary

The applicability of the McCrary-Hunter hypothesis of invariance of relative error position curves in serial learning was tested by using Ss of various levels of intelligence and pictorial, rather than verbal, stimulus materials. Educable retardates (IQ = 61), borderline retardates (IQ = 85), and normal children (IQ = 104) of the same chronological age were given

repeated presentations of six pictorial stimuli in the same order, until a criterion of two consecutively-correct trials was reached. The results indicated significantly fewer number of trials to criterion were required for the higher IQ groups. More critical to the McCrary-Hunter hypothesis is that the degree of bowness of the error curves was more pronounced for the higher IQ groups. This group X position interaction was most prominent in the initial trials, where the retardates' curve was relatively flat. With repeated trials and improved performance, however, the error curve of the retardates became more bowed, resembling that of the normals. The initial differences between the groups were attributed to differences in ability to attend to stimuli relevant to the task. It was concluded that the McCrary-Hunter hypothesis probably applies only in situations where extensive training is employed.

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Figure Captions

Fig. 1. Percentage of errors to criterion for the various serial positions.

Fig. 2. Percentage of errors on trials 1-3 and trials 4-6 for the various serial positions for the MR group (IQ=50-75).

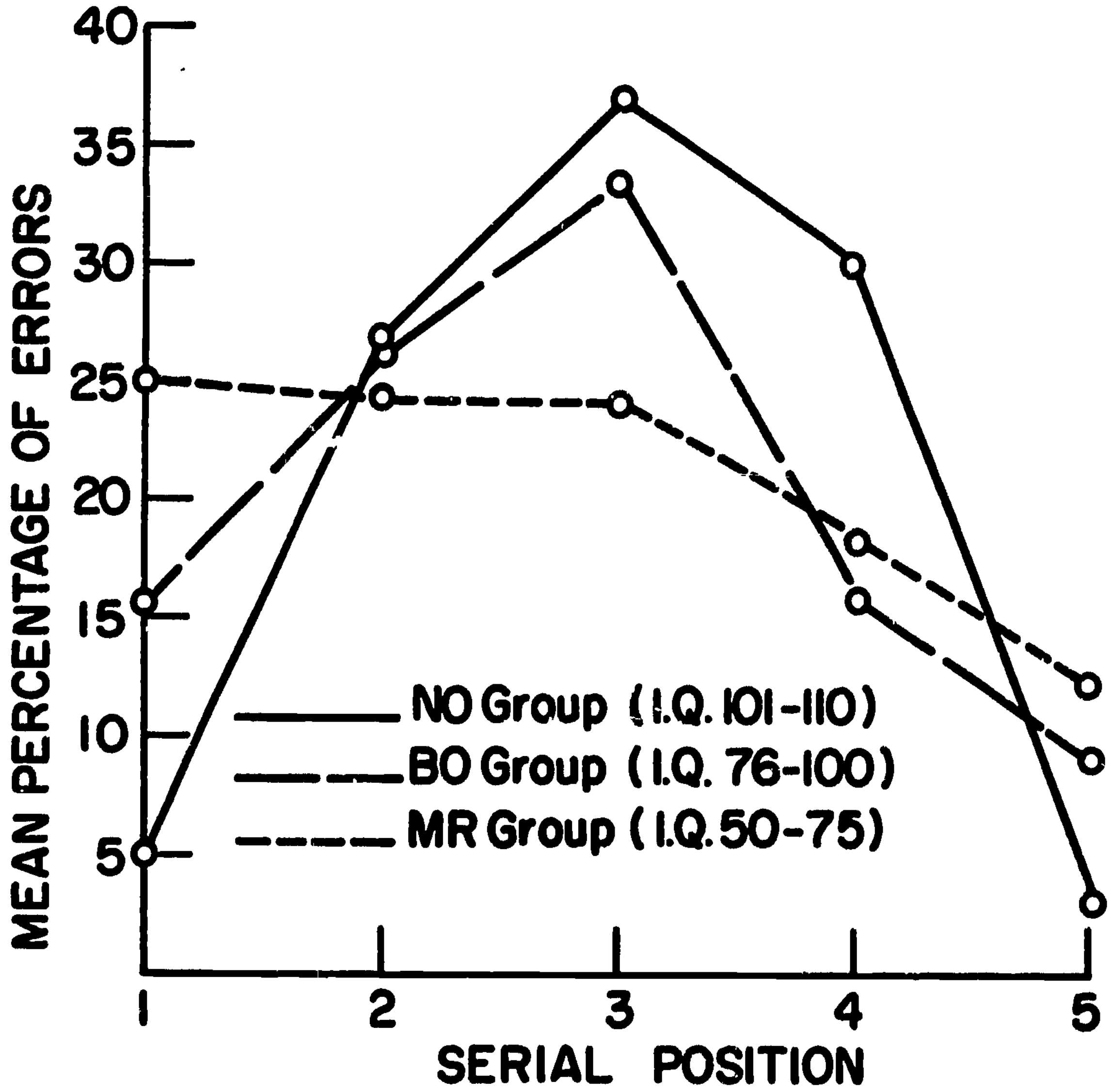
MEAN PERCENTAGE OF ERRORS
40
35
30
25
20
15
10
5
NO Group (I.Q. 101-110)
BO Group (I.Q. 76-100)
MR Group (I.Q. 50-75)
1
2
3
4
5
SERIAL POSITION

Fig. 1

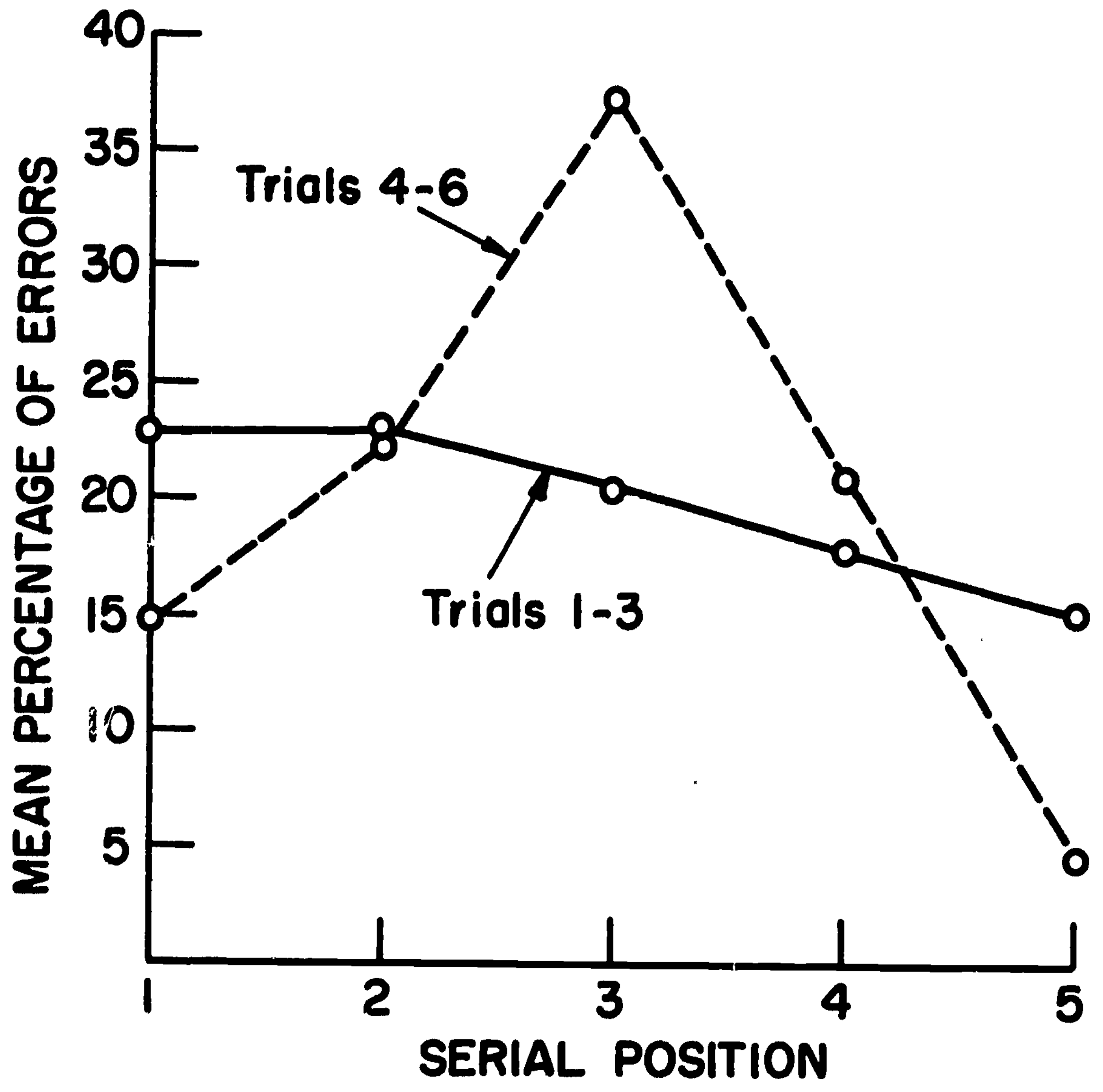
40
35
30
25
20
15
10
5
MEAN PERCENTAGE OF ERRORS
Trials 4-6
Trials 1-3
1
2
3
4
5
SERIAL POSITION

Fig. 2

The Creation of Language[1]

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A normal child, not impaired by hearing loss or speech impediment, will begin to say words around one year of age. By one-and-one-half or two years, he will begin to form simple two- and three-word sentences. By four years, he will have mastered very nearly the entire complex and abstract structure of the English language. In slightly more than two years, therefore, children acquire full knowledge of the grammatical system of their native tongue. It is a stunning intellectual achievement, routinely performed by every pre-school child. The process, as the title of this article implies, is one of invention. On the basis of fundamental biological characteristics (of which only slight understanding is presently available), each generation creates language anew.

In order to understand the creation of language, it is necessary to understand something of what is created. The structure of language is not obvious to introspection, as any who have suffered through elementary-school courses in "grammar" will attest. However, the appropriate portrayal of language is a linguistic description, not an elementary-school "grammar". The grammars of modern linguistics aim to describe the linguistic knowledge possessed by fluent speakers of a language - their linguistic "competence", as the M.I.T. linguist Noam Chomsky calls it. A recent article by John C. Marshall introduced the readers of Discovery to some aspects of these grammars, so the nature of linguistic competence can be treated briefly here.

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[1]Prepared for publication in Discovery.

Let us think about a single sentence. By so restricting our attention, we eliminate discourse, dialogue, and the exchange of ideas, all of which are important questions for understanding the development of language. In return, however, we shall gain relative simplicity without losing an accurate vision of linguistic knowledge. A sentence, of course, consists of words arranged in a particular order. But it is much more than this. In addition, a sentence has structure; the words fall together in certain definite ways. Take, for example, the simple declarative sentence, the professor berated the student. It contains two major constituents (the professor) and (berated the student); the second of these, moreover, is itself made up of constituents, (berated) and (the student). The entire sentence, therefore, possesses a hierarchical structure in which some constituents contain other constituents. This pattern can be represented by means of a tree-diagram in which lower-order constituents branch downward from higher-order constituents, the entire structure looking like an inverted elm without leaves. Examples may be found in John Marshall's article.

This much linguistic theory fulfills a fairly obvious purpose. Less obvious, but equally important, is the fact that sentences also possess a "deep" or "underlying" structure. The importance of such structure derives from the fact that it is intimately involved with our ability to extract meaning from sentences. Consider, for example, the similarities and differences between the two sentences, John is easy to please and John is eager to please. These sentences are parsed in the same way, but it is clear that they differ profoundly. In the first John is the object of the verb, whereas in the second John is the subject of the sentence. This difference is one automatically understood by every English speaker, otherwise the sentences would be incomprehensible, yet it is a difference not represented in the surface form of the two sentences.

Instead, the two sentences differ in deep structure. Grammatical relations, such as subject and object, are carried by structures not directly apparent in the surface form of sentences. We have knowledge of "abstract" linguistic features, aspects of sentences that lie behind their manifest form. The deep structures of sentences carry such abstract knowledge. Deep structures must, accordingly, be different from the corresponding surface structures, and even the simplest sentence has an underlying structure that differs in some respect from its manifest form. The problem for a theory of language acquisition is to explain the development of such abstractions.

A key linguistic concept is the notion of a grammatical transformation. A transformation is a rule of grammar that relates deep structures to surface structures. Our intuitions about sentences include abstract knowledge precisely because we have learned to use a transformational grammar. Without rules of transformation, all linguistic knowledge would have to be manifest in the surface form of sentences, and a sentence like John is easy to please would be impossible. The acquisition of transformations then, is fundamentally involved in the acquisition of language.

Let us think, not about children for the moment, but about an abstract "Language Acquisition Device", which we shall call LAD for short (alternatively, a "Language Acquisition System", or LAS - the feminine form). LAD receives a corpus of speech, which is a set of utterances, some grammatical, some not. The corpus may be large, but it is not unlimited in size. It contains, let us say, the number of utterances ordinarily overheard by a two-year old child. Upon receipt of a corpus, LAD creates a grammatical system. This, in turn, may be regarded as LAD's theory about the regularities that appear in the corpus of speech. As with any theory, LAD's grammatical system will allow predictions of future observations - predictions of which utterances will be grammatical sentences. It will also allow LAD to distinguish the fortuitous aspects of utterances from the aspects that are grammatically significant - to ignore, as Jerry Fodor put it, the distance in statute miles between a speaker and the Tower of London while attending to the small burst of energy contained in the sibilant /s/.

LAD creates a grammar by passing the evidence contained in the corpus through some kind of internal structure. The sequence can be represented by a simple flow diagram:

$$\text{Corpus of Speech} \longrightarrow \boxed{\text{LAD}} \longrightarrow \text{Grammatical System}$$

If we understood LAD's internal structure, we would understand how LAD invents a grammar. The problem is not unlike those exercises given to engineering students in which they must infer the internal wiring of a "black box" from its various input-output relations. LAD is our "black box". Its input is a corpus of speech; its output is a grammatical system. We need a theory of its internal structure, just as an engineering student does.

One hint about LAD's internal structure arises from the fact that it must be able to acquire any natural language. We do not want LAD to find Bantu easier than, say, English, or Russian, or Japanese. Whatever is contained in LAD, therefore, must be universally applicable, so our theory of LAD will be (in part) a theory of linguistic universals. One way to portray some of the internal structure of LAD is to portray the structure common to all languages. This conclusion yields an important insight into language acquisition.

Notice that the problem of understanding LAD is exactly like the problem of understanding real children. Like LAD, children are exposed to a corpus of speech, and like LAD they develop grammatical competence on the basis of this corpus. Moreover, in the case of both LAD and children, some kind of internal structure operates on a corpus of speech to obtain a grammatical system. Since the same corpus is input and the same grammatical system is output, LAD and children must have the same internal structure. LAD's internal structure, therefore, corresponds to the fundamental human capacity for language. The connection between linguistic universals and the capacity for language can be stated quite strongly: languages possess universal properties just because all languages are acquired; the renewed creation of language by children automatically imposes features corresponding to the fundamental capacity for language. Hence, these features appear universally.

The abstract grammatical relations of subject-predicate and verb-object are linguistically universal. If they reflect a fundamental capacity for language, then these abstract relations must appear very early in children's speech. They must appear early because a capacity for language is the reason (we suppose) that children acquire language quickly. The problem now is to provide evidence, if any there be, in behalf of this hypothesis.

Two kinds may be mentioned. One comes from a small American child observed by Roger Brown. The other from a small Japanese child whom I have observed. We shall take up the American child first, a boy Brown calls (for purposes of anonymity) Adam.

When Adam was two-years old, he produced large numbers of word combinations. These were sentences in Adam's grammar. Two-word combinations were most common, three-word combinations somewhat less so, and four-word combinations were very rare. These sentences were the first that Brown recorded, and probably were among the first that Adam ever produced. A small sample is given below.

Two boot

Hear tractor

See truck, mommy

Adam make tower

A gas

Roger Brown and his colleague Colin Fraser have called these sentences "telegraphic", aptly capturing their abbreviated quality. Analyzing many hundreds such sentences, Brown and a second colleague, Ursula Bellugi, concluded that Adam possessed three different grammatical classes, two of which resembled classes of adult English. There were nouns (<u>boot</u>, <u>tractor</u>, <u>truck</u>, <u>mommy</u>, <u>Adam</u>, <u>tower</u>, <u>gas</u>), verbs (<u>hear</u>, <u>see</u>, <u>make</u>), and a third class of "modifiers" (<u>two</u> and <u>a</u> in the sentences above, plus adjectives, <u>this</u>, <u>that</u>, <u>other</u>, and '<u>nother</u>). Adam's class of modifiers thus comprised several adult classes, but even his noun and verb classes failed to observe certain adult distinctions - for example, the difference between count (<u>boot</u>) and mass (<u>gas</u>) nouns.

Looking at Adam's sentences, an adult feels intuitively that they honor the basic grammatical relations of subject-predicate and verb-object. <u>Hear tractor</u> appears to be a verb and an object. <u>Adam make tower</u> appears to be a subject and a predicate, and the predicate in turn appears to be a verb and an object. And so on. These intuitions are quite compelling, but of course they might also be quite wrong. Adam may not have intended these sentences in the way that we interpret them. We need another means of examining Adam's speech that does not depend on our understanding of what he wanted to say.

One approach is based on the following calculations. With three grammatical classes, there are $(3)^2 = 9$ different two-word combinations, and $(3)^3 = 27$ different three-word combinations. If Adam were combining words at random, we should expect to find all (or nearly all) these nine and 27 different combinations. However, they do not all honor the basic grammatical relations. Only four of the two-word combinations directly express one or another grammatical relation, and only eight of the three-word combinations do so. If Adam were attempting to use the basic grammatical relations from the first, he would restrict himself to these admissible patterns.

That is exactly what Adam did. In eight hours of recorded speech, involving some 400 sentences, there were examples of every admissible combination but no examples of inadmissible ones.

It is not obvious that this should be the case on a priori grounds. Parental speech presents many examples of inadmissible combinations of Adam's grammatical classes. Take, for example, the combination, verb-verb-modifier. Because of the double verb, it does not express a grammatical relation, and sentences of this type - for example, come eat this - did not appear in Adam's early speech. But come and eat this is surely a common sentence-type in adult speech. It did not serve as a model for Adam because the adult sentence contains several transformations not yet part of Adam's grammatical competence. Lacking the appropriate transformations, there was no way for Adam to express the basic grammatical relations, so the sentence-type did not appear.

Adam's restriction of the variety of sentence-types is one kind of evidence that children include abstract relations in their earliest speech. A second kind of evidence comes from a child acquiring a radically different language, Japanese.

Unlike English, Japanese is a postpositional language. Very roughly, postpositions correspond to English prepositions, but not all postpositions can be translated into prepositions, and conversely. Among the postpositions without an equivalent in English are two, wa and ga, that indicate the grammatical subject of sentences. According to the linguist S.-Y. Kuroda, wa and ga are carried into the surface structure by transformations that operate on the deep structure. In order for a child to acquire these transformations, therefore, the abstract relation of "subject" must already be available. If it were not, a child would not be able to use wa or ga appropriately.

The child whose speech I have observed is a little girl, living in Tokyo, who hears only Japanese, and, at the time of this writing, is two years old.

In the interest of maintaining the tradition begun by Brown, I shall call her Izanami, after the goddess of Japanese mythology who helped create the world.

Izanami's sentences at this time are all two-, three-, and occasionally four-words long. She is, therefore, at the same stage as Adam, still within the earliest phase of grammatical development. In eight hours of recorded speech, there were 100 occurrences of ga, but only 6 occurrences of wa. All Izanami's uses of ga were appropriate, and she rarely omitted the postposition when it was called for. It is thus clear that Izanami is able to express the basic grammatical relation of "subject" by means of the ga-transformation. Her earliest speech contains an abstract feature, as it must if a linguistic universal reflects an aspect of the fundamental capacity for language.

But what of wa? It is quite clear that Izanami does not know how to use it. Since she has the relation of "subject" available to her, something must be blocking the wa-transformation itself. In parental speech, wa and ga appear in the same places, after the subject, so parental speech cannot explain the absence of wa from Izanami's grammar. Moreover, wa is used by Izanami's mother twice as often as ga, which if anything would favor the acquisition of wa. The explanation of wa's absence seems to be the different uses to which wa and ga are put by Japanese grammar. Although both mark the subject of a sentence, their semantic implications are very different, and children appear to be sensitive only to those embodied in ga.

The postposition wa is required whenever the predicate of a sentence is something attributed to the subject. It is the postposition for permanent conditions, the semantic significance of which is often translated into English by the expression "as for..."; as for this, it is a flower, or as for cats, they eat goldfish. In such cases, the sentence presents an unchanging and "necessary" connection between the subject and the predicate.

The postposition ga, in contrast, is required whenever the subject of a sentence is merely linked to the predicate, the two standing in an equal and temporary relation. It is the postposition for momentary description, as in a man is standing on the corner, or the cat ate the goldfish. In such cases, the sentence presents a fortuitous and "unnecessary" connection between the subject and the predicate.

It appears, therefore, that children attempt to express momentary description when employing the abstract relation of "subject", not permanent connections. This is a surprising result, and for several reasons.

One of the examples calling for wa above is a definition. In Japanese it would be, roughly, this -wa is a flower. We can be certain that Izanami understands sentences of this type in her mother's speech. They are the only way in which she receives new information and new vocabulary. Yet, wa does not appear in Izanami's grammar. Related to the use of wa in definitions is its use in describing stable relationships. One would say to a recalcitrant child, people -wa eat their supper. It is often assumed that children first develop grammar in an effort to name stable relationships in the physical world. Izanami belies this hypothesis. In fact, on Izanami's evidence, naming and grammatical development have nothing whatsoever to do with each other. All instances of appellation require wa in Japanese. Because Izanami, just as all children, names objects a great deal, her postposition would have to be wa, not ga, if there were a connection between the acquisition of names and the acquisition of grammar. In fact, however, they are entirely independent.

Children exposed to English and children exposed to Japanese both include abstract features in their earliest speech. To these children may be added a third child exposed to Russian, who, according to Dan I. Slobin, also included abstract features in his earliest speech. In spite of radical differences in the conditions of learning, therefore, children are found to do similar things. They do so because of their shared inborn capacity for language.

Our account of language acquisition is not yet complete. Ultimately, children do different things when the conditions of learning are different. Exposure to English does not lead to competence in Japanese! What has been left out of account is the acquisition of transformations. In considering this aspect of development, we shall see something of how a child brings his capacity for language into contact with the speech of his local community.

The general idea of a transformation is an instance of what Chomsky calls a "formal" universal of language. Transformations appear in all languages, but the particular transformations of each language are idiosyncratic. Aside from sound, in fact, transformations are the main source of linguistic uniqueness.

How do children acquire transformations? Unfortunately, there is no definite answer. However, one view is that the process takes place in the same manner as scientific inference. On the basis of their capacity for language, children formulate hypotheses about regularities observed in parental speech. Each hypothesis is evaluated against further evidence - additional parental speech, parental reactions to a child's own speech, etc. In pursuing this empirical program children may even perform linguistic experiments, the equivalent in most respects of experiments conducted in scientific laboratories.

The experimental aspect is perhaps the most interesting, for it involves a symbiotic exchange between a child and his parent. Roger Brown has called attention to a common phenomenon in parent-child dialogues. Very often parents imitate children, and in so doing, enlarge a child's sentence into completely well-formed English. If a child says doggie bite, a parent may reply, yes, he is biting, adding the auxiliary verb, is, and the progressive inflection,

-ing. Both additions exemplify details of English transformations, and do so within the context of the child's own speech. Brown calls this process "expansion". He finds that parents expand approximately 30% of what two-year old children say.

Expansions provide a natural experiment for a child. Suppose a child does say doggie bite. There are many possible expansions. In addition to yes, he is biting, an adult might say he bit, he will bite, his biting....., and probably more. Each expansion holds constant the elements preserved in the child's sentence while varying the particular transformation, just as a real experiment holds some factors constant while varying others. Moreover, the observations in a real experiment are relevant to the hypothesis under test and the same is true in expansion. Suppose that context indicates to the to the parent that the child is talking about an event going on at the moment. The only possible expansion would then be yes, he is biting. If the child were in fact talking about this on-going event, and if he were looking for some way to express this idea, the expansion would provide relevant information.

There is one respect in which expansions and real experiments differ. An experimenter has some control over his observations, but a child does not. The child above may have meant the dog bit yesterday, in which event the expansion yes, he is biting would have provided mis-information. It is unlikely that this happens often. Presumably, one reason that adults do not expand more than 30% of the time is that 70% of the contexts are not clear, and so offer no guidance as to what a child means. Parents play it safe with this powerful tool of science.

A capacity for language would contain a great deal more than the matters discussed in this article - the basic grammatical relations and the general idea of a transformation. It would certainly include, in addition, an ability to construct a dictionary of some kind, as well as certain formal rules for using it. There are also universal phonetic principles, such as the stock of "distinctive features" into which all speech sounds may be resolved, which probably correspond to a part of the capacity for language. There are probably universal principles whereby linguistic knowledge is converted into actual speaking or listening, although very little is known about this at the present time. (It is significant, nonetheless, that all children speak fluently, no matter how primitive their grammars may be.) All these things, plus still others not yet imagined, may make up the capacity for language, and may, therefore, contribute to the astonishing speed with which children acquire their native tongue.

However, the possibility is worth considering that very little of this is, in fact, a capacity for <u>language</u>. Much of what has been discussed in this article may actually be the linguistic manifestation of a very general, though still inborn, cognitive capacity. If this is true, then the study of language acquisition may provide insight into the very basis of mental life. For if the capacity for language is but a special case of more general cognitive capacity, it would follow that the latter must have all the universal properties of the former. In short, the appropriate theory of mind may be a transformational system in which a vast range of complex ideas is converted into a much smaller range of abstract cognitive structures, just as a true grammar converts an infinite range of sentences into a limited number of abstract deep structures. Needless to say, the exploration of this possiblity has only begun.

Nonetheless, if we suppose for the moment that cognition is a transformational system, it is possible to consider the creation of language in a larger sense, speculating on the evolution of language, particularly on the emergence of languages of the sort now present in the world. The argument will be that evolution has consisted of the addition of specific transformations -

the rules that distinguish one language from another. The primeval grammar may have been mainly free of transformations. It may have been a system in which the features now contained in the deep structure of sentences were very nearly all located in the surface structure.

But if primeval grammar was mostly free of transformations, it must have been enormously complex. Without transformations to relate a large variety of surface structures to a limited number of abstract structures, all the different surface types must have been understood directly, instead of indirectly through deep structures. A grammar of that degree of complexity would have required a long time to acquire. The suggestion, therefore, is this: specific transformations have evolved in order to make the acquisition of grammar possible at earlier ages. The pressure for evolution would have arisen from the need to express great conceptual variety through economic means. The consequence of evolution would have been a vast reduction in the complexity of language without loss of expressive power. The conceptual and linguistic systems would have been brought into closer alignment.

The innovators of such evolutionary change could only have been children attempting to acquire language. Language slowly became transformational because an occasional child reformulated the speech received from adults by inventing a transformation, an invention made possible by his general cognitive capacity. This, of course, is what contemporary children do, too - invent transformations. The process of invention would be the same for children of the remote past as for children of today. The difference is that a contemporary child is presented with sentences that reflect the presence of transformations, whereas a child of antiquity was not. But if the basic cognitive abilities of children in antiquity were roughly the same as now, this very fact - that transformed sentences signal the presence of transformations - explains how each innovation in the evolution of language could have been passed on to the next generation. The process of evolution would have been the process of language acquisition. Each new transformation would have slightly changed the corpus of speech that the innovator, now mature, presented to his progeny. His progeny, then could have acquired the transformation in the usual manner, just as do contemporary children, and so language could have advanced. The creation of language in antiquity and the creation of language by contemporary children are not, under this scheme, basically different. This assertion is not the same, of course, as the claim that "ontogeny recapitulates phylogeny". Indeed, in a sense, it is the opposite. Whereas the initial language of contemporary children is comprised mostly of deep structures, the initial language of antiquity was comprised mostly of surface structures.

The direction of evolution, according to the account just given, must have been toward simplicity, not toward complexity, as most theories of linguistic evolution have it. According to the present view, language changed from an extremely complex system, largely free of transformations and taking many years to acquire, to a much simpler system, rich in transformations and taking only a few years to acquire. Thus, it is the presence of transformations in contemporary language, coupled with a general cognitive capacity to use transformational system of this kind, that allows children to develop language with the great speed that they do. Indeed, transformations evolved precisely in order to make possible this stunning intellectual achievement, routinely performed by every pre-school child.

On Theories of Language Acquisition

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Abstract

The application of S-R principles does not lead to viable theories of language acquisition. Such theories account for the development of a phrase-structural rather than a transformational grammar, and so can be rejected on strictly linguistic grounds. A nativist theory, which assumes that children are endowed with knowledge of various linguistic universals, can, in principle, account for the acquisition of a transformational grammar, and is lent some support by the appearance of such universals in the earliest speech of children exposed to English, Japanese and Russian.

Those interested in linguistic development use the locution "language acquisition" freely. Conferences are so titled, lectures on the subject are given, and the present paper employs the phrase in its title. However, in fact, the term "language acquisition" is without meaning. There is no sense in which one may speak of acquiring language, as if that were an object apparent to perception. The locution omits a crucial step in our theoretical efforts. The missing part is the necessity of first understanding what is meant by "language"; only by having defined this term is it possible to ask how language so defined might be acquired. This requirement is inescapable. Theories of linguistic development that make no explicit reference to an analysis of language are illusory. In truth, they do assume some theory of language; however, they do so implicitly, and suffer thereby the disadvantage of not knowing precisely what it is they are to explain. A major requirement, then, for any theory of language acquisition is that it explains a known phenomenon, which means that theories of development must be related to particular grammatical analyses, to particular theories about language itself.

Imposing this requirement helps clarify several recent controversies among theoreticians concerned with child language. I have in mind here the exchange of papers between Bever, Fodor, and Weksel (1965a; 1965b) on the one hand and Braine (1965) on the other, as well as the debate over the need for nativist theories of development (see Chomsky, 1965; Katz, 1965; and McNeill, 1965 for one side of this debate). A good deal of what is written below is devoted to one aspect or another of these controversies. However, it is first necessary to consider two other basic matters, each relevant to the general requirement stated in the preceding paragraph. The first concerns the possibility of using studies of child language to decide issues in linguistics proper; the second concerns the possibility of studying children's linguistic performance without, at the same time, studying their linguistic competence. Both possibilities have been suggested (Braine, 1965; Haas, 1965), but neither meets the general requirement that theories of acquisition must be related to theories of language.

In a footnote, Braine writes:

"If there is a possibility that the simpler of tr possible grammatical solutions might require the more complex acquisition theory, then the domain over which simplicity is taken cannot be restricted to grammar alone and must include acquisition theory--otherwise the grammarian merely purchases simplicity at the psychologist's expense." (1965, p. 491)

Braine was writing in response to the remark of Bever et al. that theories of acquisition must somehow account for the ability of children to develop abstract linguistic features, that is, features (such as the base structure of sentences) that are never made manifest in speech. Braine then suggests the following grammatical reform:

"...surely the gain in simplicity accruing to an acquisition theory for taking the underlying structure as overt in simple sentences would likely be so great that it would more than compensate for an increase in grammatical complexity involved in writing the grammar so that the underlying structure was overt." (1965, p. 491)

Braine's proposal, in short, is to construct a new grammatical system, taking into primary consideration such factors as available theories of learning. The difficulty with this proposal is that it confuses two distinct questions--the nature of linguistic competence and the nature of the device that acquires linguistic competence--and so violates the basic requirement stated above. A descriptively adequate grammar, to use Chomsky's (1965) term, accurately and explicitly states the linguistic competence of fluent speakers. It is a difficult matter, of course, to evaluate the adequacy with which a grammar does this, but the lack of a psychological theory is no reason to reject a proposed grammatical solution. That is rather like rejecting the calculus because one does not have a theory of how Newton thought of it. The problem, instead, is to formulate a psychological theory that is adequate to explain the acquisition of grammar. Either one does a novel kind of linguistics, attempting to discover the kind of linguistic competence that could be explained by current psychological theory, or one attempts to see how a particular characterization of competence, say, transformational grammar, could be acquired. Braine advocates the former course; a more critical appraisal will be advocated here.

A second consideration in formulating a theory of language acquisition revolves around the distinction between competence and performance. The problem arises because of the suggestion (by Haas, 1965, for example) that studies of language acquisition be confined to studies of children's linguistic performance. The question concerns the contribution that studies so restricted can make to a theory of language acquisition. The argument here will be that their contribution is minimal, again, because of the general requirement that theories of language acquisition be related to particular theories of grammar.

The difference between the study of competence and the study of performance is a difference in goals. It is not a difference in scientific strategy or a divergence of opinion on how best to approach some common problem. On the contrary, choosing to study performance defines a problem completely different from the problem of language acquisition. Studies of performance presumably try to discover how external conditions influence children's verbalizations, how verbalizations change with age and experience, how linguistic abilities influence performance on non-linguistic tasks, and so on. They are not intended to reveal the linguistic information that children acquire. This chore falls to the student of children's competence, and it requires specification of the linguistic system being acquired.

There is, however, a second type of performance study, more intimately related to theories of language acquisition. Knowledge of a language is gained through a kind of linguistic performance, and a theory of language acquisition should attempt to characterize it. At the moment, absolutely nothing is known of this performance. In this case, however, there exists a clear priority of study. It is first necessary to discover what a child learns before reasonable hypotheses can be framed about how he learns it. This is the standard empirical assumption, offering observation as an effective safeguard against empty speculation. In the present context, it means that studies of children's developing competence must come before we can study how competence is developed. The remarks below are all addressed to the first of these questions.

The Problem of Language Acquisition

Superficial acquaintance with young children reveals one of the problems that a theory of language acquisition must face. At age 18 months or so, children begin to form simple two- and three-word sentences. By age 4 years, they are able to produce sentences of every conceivable syntactic type. In approximately 30 months, therefore, language is acquired, at least that part of it having to do with syntax, an achievement that any theory of linguistic development must consider.

In keeping with the general requirement stated above, we must also specify what it is that children acquire so rapidly. On this there can be little doubt. It appears to be a transformational grammar. For arguments and evidence in support of transformational grammar, see Chomsky (1964, 1965), Chomsky and Halle (1965), Katz (1966) Katz and Postal (1964), Postal (1964), and the many papers referred to therein. The problem of language acquisition thus can be stated clearly. We aspire toward a theory of linguistic development that will explain the emergence of a transformational grammar by age 4 years, with the period of active acquisition covering a span of approximately 30 months. Putting the problem in this way, many of the proposals for explaining language acquisition that might be derived from traditional psychological theories are simply inappropriate. The next section passes some of these in review.

Some Traditional Accounts of Language Acquisition

Imitation and overt practice. An early and popular view of linguistic development was that imitation and overt practice played a decisive role in the emergence of language (e.g., Allport, 1924). A child was held to acquire novel forms from parental speech through imitation; the forms so acquired then became entrenched as smoothly operating linguistic skills through practice. Despite its popularity, numerous objections can be raised against this simple view. The most telling, perhaps, is that many aspects of linguistic competence are simply not available for imitation, being part of the deep structure of language; for the same reason, they are not available for practice in a child's own speech. There is also evidence that practice or imitation does not benefit acquisition even when linguistic features are available in the manifest form of sentences. Ervin (1964) compared the grammatical complexity of the speech that small children produced spontaneously to the complexity of the speech that the same children produced in imitation of adults. For every child, save one, there was no difference in complexity. The one exception produced more primitive speech in imitation than in spontaneous discourse. Instead of advancing linguistically when repeating adult speech, children assimilate the model to their current system. Thus, if a child characteristically omitted the progressive inflection -ing form spontaneous speech, his imitation of Adam is running fast would be Adam run or run fast, not the progressive Adam running or running fast.

In a second study reported in the same paper, Ervin presents evidence that overt practice likewise has little effect on grammatical development. It is well known that children regularize strong verbs in the past tense, producing such forms as doed, comed, runned, etc. Less well known, however, is the fact that such regularizations are a relatively late development in language acquisition. Initially, children produce strong verbs in the correct past-tense form. Children say did, came, and ran before they say doed, comed, and runned. Indeed, the first verbs children mark for past tense at all are the strong verbs, correctly formed. The reason for this is not difficult to see. The strong verbs are all frequent in parental speech. A child is exposed to many examples of each, and they are probably acquired and registered as independent vocabulary. Once having acquired these verbs in their correct past-tense form, children, too, find many occasions to use them. _Did_, _came_, and _ran_, therefore, are frequently practiced and should be solidly established in child's repertoire. In fact, however, they are not. Ervin searched her records for the first occurrence of the regular past-tense inflection, -_ed_. In some children, it appeared first on these same strong verbs, as if the children were overgeneralizing before there was anything to overgeneralize from. In other children, the -_ed_ inflection appeared first on weak verbs but very shortly thereafter on strong verbs also. In all cases, the correct strong forms disappeared. The apparent paradox of children saying _runned_ before they say _walked_ is doubtlessly an artifact of sampling--strong verbs, being more frequent, had a better chance than weak verbs of appearing in Ervin's samples. But in all cases, the fact remains that an infrequent form, the weak-verb inflection, easily dominated the highly practiced strong forms. Indeed, for some children the frequency of weak verbs marked for past tense was so low that the first occurrences of the regular -_ed_ did not appear at all in Ervin's records.

The cause of this remarkable instability of the strong verbs seems to be that each strong verb, although frequent, is unique unto itself, whereas the weak verbs, although infrequent, all exemplify a pattern. Apparently patterns weigh more heavily with children than frequency of repetition does, presumably because children search for linguistic features that can be expressed by rule. When the rule is formulated, it is applied wherever called for, contrary past experience notwithstanding. One suspects from evidence such as this that the acquisition of linguistic competence proceeds according to principles quite different from the ordinary laws of learning.

Simple and mediated S-R explanations. There are general reasons why the ordinary laws of learning should not apply to language acquisition.

The phonemena to be explained in the acquisition of language are highly dissimilar from the phenomena traditionally encompassed by S-R theories of learning, and laws devised to explain the latter should not be expected to apply directly to the former. This point was forcefully argued by Chomsky (1959) with reference to Skinner's views on language, but the argument has wider scope, applying to behaviorist theories in general. The most apposite passage, perhaps, is the following:

"The notions _stimulus_, _response_, _reinforcement_ are relatively well defined with respect to bar-pressing experiments and others similarly restricted. Before we can extend them to real-life behavior, however, certain difficulties must be faced. We must decide, first of all, whether any physical event to which the organism is capable of reacting is to be called a stimulus on a given occasion, or only one to which the organism in fact reacts; and correspondingly, we must decide whether any part of behavior is to be called a response, or only one connected with stimuli in lawful ways. Questions of this sort pose something of a dilemma for the experimental psychologist. If he accepts the broad definitions, characterizing any physical event impinging on the organism as a stimulus and any part of the organism's behavior as a response, he must conclude that behavior has not been demonstrated to be lawful. In the present state of our knowledge, we must attribute an overwhelming influence on actual behavior to ill-defined factors of attention, set, volition, and caprice. If we accept the narrower definitions, then behavior is lawful by definition (if it consists of responses); but this fact is of limited significance, since most of what the animal does will simply not be considered behavior." (Chomsky, 1959, p. 30)

On Chomsky's argument, theories restricted to the notions _stimulus_, _response_, and _reinforcement_ are either vague or irrelevant when applied to language--vague when these terms are broadly conceived, irrelevant when they are narrowly conceived. Thus if we take the terms _response_ and _stimulus_ literally, as being behavior evoked by known external conditions, we must conclude that very little linguistic behavior consists of responses, and that very much linguistic behavior is unstimulated. It is not the case that "I forgot my appointment yesterday" is evoked by a stimulus, if by stimulus anything definite is meant, and accordingly, the utterance is not a response, but instead is an unstimulated vocalization. If one imposes the S-R paradigm, such behavior simply falls outside the system. If, on the other hand, one attempts to broaden the concepts of stimulus and response so as to include utterances like "I forgot my appointment yesterday," the critical terms become vague in the extreme and circular as well, S standing for "Some memory that caused speech" and R for " some utterance evoked by that memory." The impasse arises form the inappropriateness of the terms _stimulus_ and _response_ for the analysis of such complex phenomena as language.

To reject simple S-R theories is thus relatively easy, and it is a bad joke even to consider the applicability of such views to the acquisition of a transformational grammar. This statement will occasion no surprise. Many psychologists have reached a similar conclusion on the inability of simple S-R theories to explain complex phenomena. It now seems widely agreed that elementary theories of the type criticized by Chomsky are inappropriate for all except the most restricted situations. Language, in particular, is regarded as a counter-instance (Jenkins & Palermo, 1964). However, instead of reconsidering the suitability of the basic S-R paradigm, an effort has been made to modify it so as to represent events internal to the language user. External S and R connections are mediated by internal ones. Hopefully, linguistic structure can be captured by s and r if not by S and R. This reformulation of the basic S-R paradigm appears to avoid the most serious of Chomsky's criticisms (but see below, p. 12). Mediation theories apparently do not maintain that one will respond overtly whenever a stimulus is present, nor do they seem to hold that every overt act must have a corresponding external stimulus. Instead, external stimulation may result in internal responses, and overt behavior may be evoked by internally produced stimuli. Mediation theories thus seem to gain considerably in flexibility, avoiding the absurdities into which their simpler ancestor may be forced.

Jenkins and Palermo (1964) have made an initial effort to develop a mediational account of language behavior. They were concerned with the formation of grammatical classes, such fundamental categories of grammar as nouns, verbs, and adjectives. The critical assumption is that mediation paradigms that are naturally embedded in speech develop associative bonds among words. Random encounters with <u>John is big</u> and <u>John is jolly</u>, for example, would teach a child that <u>big</u> and <u>jolly</u> are members of the same grammatical class. Words thus belong to the same class when associations are established among them in mediation paradigms, in the present instance, the paradigm for creating "response equivalence." Objections can be leveled against this claim--for example, that it assumes associative strength to exist among all members of a grammatical class, no matter how infrequent some members are[1], an assumption rendered doubtful by the fact that <u>boy</u> and <u>ambergris</u> are both unmistakably nouns. A more important question, however concerns the ability of mediation theories to account for the development of transformations, and at first glance it may seem that they are more successful at doing this than at accounting for the formation of grammatical classes.

Consider the following facts about acquisition of the negative transformation in English (Bellugi, 1964; summarized in McNeill, 1966). In the earliest phase of development, negative sentences are formed simply by affixing no or not to an otherwise affirmative sentence. A child will say no drop mitten or not fit. Somewhat later, he uses don't and can't, apparently as independent vocabulary items, as in I don't sit on Cromer coffee or he can't do that. The negative expressions, don't and can't, seem to be words, not constructions, because -n't appears nowhere else, do and can not yet occurring alone in the child's speech. Finally, some three to six months later, do and can appear in affirmative sentences (he can reach it, do you want it?) as well as in negatives, and the child appears to have developed a transformational system. At least two transformations are involved. One positions an auxiliary verb (can or do) in sentences, the other attaches the negative element to the auxiliary. A mediational interpretation of the emergence of these transformations would be something like the following.

The first requirement is to establish the auxiliary verbs. Random encounters with such phrases as it did and it can in parental speech would establish a paradigm whereby did and can become associated, thus forming a class. Next, random encounters with it did and it didn't would establish did and didn't as a class, and further encounters with it can and it can't would establish can and can't as a class, thus locating negation in the auxiliary system as English requires. However, this fails to provide a single negative element, yielding instead a negative for each auxiliary--one for did and one for can. A third mediation paradigm solves the problem. Since can and did are already established as a class, further encounters with can-n't and did-n't would establish the first n't and the second n't as a member of a class, yielding thereby a single negative element, n't Thus, invoking three mediational episodes can account for the child's development described above.

However, note that the system developed is radically different from the one represented by the auxiliary and negative transformations of English (Klima, 1964). In fact, the emergence of transformations has not been explained at all. Instead, some surface characteristics of negated English sentences have been derived without reference to structures even remotely like those produced by a transformational grammar. In order to apply mediation theory, therefore, we find ourselves inventing a language rather than attempting to explain the acquisition of a natural language, as this concept has been defined. This outcome appears to be an inevitable consequence of mediation theory.

It was said above that mediation theories escape Chomsky's major criticisms of simple S-R theories. However, even this claim has been challenged by Fodor (1965), who argued that mediation and simple S-R theories are logically identical, so that the criticisms made of one apply with equal force to the other. The context of the argument is the mediational account of meaning as provided, for example, by Mowrer (1960) and Osgood, Suci, and Tannenbaum (1957). The change of context is unimportant for present purposes since Fodor's argument focuses on the assumption that mediating responses derive from overt responses, an assumption shared by Jenkins and Palermo (1964) as well as by Mowrer and Osgood et al.

According to mediation theory, a word, <u>hammer</u>, refers to an object, a hammer, because the word serves as a conditioned stimulus eliciting some part (r_t) of the total reaction (R_t) elicited by the object. In the case of <u>hammer</u>, the total reaction would include hand and arm movements, characteristic postures, etc., whereas r_t would be some fraction of this total. The part (r_t) conditioned to <u>hammer</u> presumably consists of the "lightweight" components of the total reaction (R_t), that is, those components most easily conditioned.

Fodor points out that the r_t conditioned to <u>hammer</u> must be distinct from the r_t conditioned to other (non-synonymous) words, such as <u>coffee cup</u>, else the r_t to <u>hammer</u> would be as much part of the gross response (R_t) to the other object (a coffee cup) as it is part of the gross response to a hammer. In other words, since <u>hammer</u> and <u>coffee cup</u> have different meanings, it must be the case that the two r_t elicited by each word are distinct parts of distinct R_t.

It then follows that the r_t to <u>hammer</u> is different from the r_t to <u>coffee cup</u> only because the R_t to a hammer is different from the R_t to a coffee cup. The mediating responses all originate in the corresponding external responses. But since this is the case, there can be no distinction between r_t and R_t. Wherever one is different, the other is different, and conversely. Whatever properties may be ascribed to one must be ascribed to the other, and so the difference between simple and mediated S-R theories evaporates, save that mediation theory posits unobservables whereas simple S-R theory does not. Hence, Chomsky's criticisms of simple S-R theory apply also to mediated S-R theory, and most utterances can be regarded neither as responses nor as stimulus-evoked. In short, most speech falls beyond the scope of the system.

Thus, we have moved full circle. In application to problems of language, various formulations of S-R theory, whatever their merits for other problems, are inappropriate because the phenomena of language have properties that cannot be captured in such terms. In consequence, a psychological account of transformationa grammar is not achieved by application of S-R theory, a fact evidenced by the redefinition of the problem that automatically results when the effort is made. Perhaps the clearest example of this process--the automatic reformulation of linguistic phenomena--appears in the work of Braine (1963a, 1963b,1965), to which we now turn.

Contextual generalization. Braine (1963a) discusses two processes in the development of linguistic competence. One is "contextual generalization," the other is a type of restricted association that is supposed to hold among various function words and other grammatical classes. With these two processes, Braine argues, children develop the fundamentals of grammar.

As a child hears sentences from his parents, he notices from time to time the position that particular words occupy in them. For example, hearing Adam's tower is tipping over, a child may notice that tower occurs in the first half of the sentence. It is relative position that a child observes. The process of contextual generalization then carries tower into homologous, first-half positions in other sentences. Contexual generalization is regarded as being not different in principle from ordinary stimulus or response generalization, and is seen as a special case of these more general processes in which the property that mediates generalization is temporal location in an utterance. A child learns that certain words may occur in particular temporal locations, and then generalizes these to homologous locations in other sentences. With respect to the linguistic problem, the merit of contextual generalization is that it provides a basis for productivity, the capacity to produce or comprehend novel but grammatical utterances.

At first, a child will know few temporal positions for words in sentences. Perhaps he knows only one. Braine (1963b) introduces the term "pivot" to describe this situation. Children's very early sentences are constructed by juxtaposing pivot and "open" words, open words being everything not in the pivot class. The pivot class characteristically contains few members, each used with high frequency. In addition, the pivot class is relatively "closed," that is relatively slow to take in new members. All these properties of the pivot class can be explained on Braine's assumption that the discovery of relative position is a slow process, so that at first children know the position of few words. In addition to these observations, Braine (1963a) cites several experiments performed with artificial "languages" that support the assumption that contextual generalization exists.

A child learns not only the position of words through this process, but also the position of phrases within sentences. Thus, as a result of contextual generalization, the hierarchical structure of sentences comes to be part of children's competence. The word <u>tower</u> is both in the first half of the sentence <u>Adam's tower is tipping over</u> and in the last half of the phrase <u>Adam's tower</u>. Through contextual generalization, a child learns to construct sentences in which the first half consists of phrases of the <u>Adam's tower</u> type and the second half consists of phrases of the <u>is tipping over</u> type, and he also learns to construct phrases in which the second half consists of words like <u>tower</u> and the first half consists of words like <u>Adam's</u>.

While thus learning the position of words and phrases, a child is also held to learn associations between function words, inflections, auxiliary verbs, and other grammatical classes. Thus, from <u>Adam's tower is tipping over</u>, a child could learn to associate <u>is</u> with <u>-ing</u> as well as <u>'s</u> with <u>tower</u>. From a slightly different sentence, <u>Adam's towers are tipping over</u>, he could learn in addition to associate <u>-s</u> with <u>are</u>. Two effects result. One is grammatical concord--as in the number agreement embodied in <u>towers are</u>, or in the contingency between <u>is</u> as an auxiliary and <u>-ing</u> on the following verb. A second effect is the unification of phrases--the fact that words in the same phrase belong together in a manner that words in different phrases do not, a phenomenon accounted for by such associations as <u>'s</u> - <u>tower</u>.

Bever, Fodor, and Weksel (1965a) have lodged vigorous criticisms against Braine's theory, and in light of the general requirement on theories of language acquisition set forth before, their criticisms appear to be unanswerable. The difficulty, quite simply, is that Braine's theory accounts for the acquisition of the wrong grammar. In order to apply the processes of contextual generalization and restricted association, it is necessary to reformulate the grammar of English in several important ways. These modifications are made clear in Braine's (1965) reply to Bever et al., so we can trace through the debate, and at the same time introduce some characteristics of transformational grammar, by contrasting Braine's language with what is known of English.

The logic of a transformation rule involves a distinction between the base (or covert) and the surface (or manifest) structure of sentences (Chomsky, 1957, 1965). A rule of transformation, the passive, for example, operates on complete sentence structures, or fragments thereof, rearranging, inserting, or deleting so as to convert base structures into surface structures. As a result of the transformation, surface structures differ in various ways from base structures. This arrangement is fundamental to the concept of a transformation rule. Since natural languages are transformational, the distinction between covert base structures and manifest surface structures is likewise fundamental to the phenomenon of language.

The processes of contextual generalization may account for the acquisition of a phrase-structure grammar, although there is even dispute on this (Bever et al., 1965a). Be that as it may, however, a crucial objection is that it would be impossible to develop transformations with these processes of acquisition, a limitation implicitly recognized by Braine in the passages quoted above (p. 2). Braine introduces a new definition of transformation

(Braine, 1963a; repeated in Braine, 1965) whereby some sentence types are produced from other sentence types via various "sub-languages." A Sub-language operates on the surface structure of one sentence to yield the surface structure of another sentence. The choice of terminology is unfortunate. Although Braine calls these sub-languages "transformations," they should not be confused with the operations also called "transformations" in generative grammar. The possibility of confusion is increased further because Brainian transformations are intended to yield sentences with the same superficial form as sentences produced by some of the transformations in generative grammar. Thus, there is a sub-language for the passive, another for questions, etc. The whole forms a "transformational" grammar without base structures. The difference between the two kinds of transformation turns on Braine's assumption that English sentences do not have underlying structure. Thus, contrary to Braine's assertion that the problem of transformations is "... only very tangentially relevant..." (1965, p. 484) to his debate with Bever et al., the treatment of transformed sentences is the central issue to be considered.

The question is: How are sentences to be derived? The difficulties inherent in Braine's answer to this question can be demonstrated by comparing the derivation of a given type of sentence provided by his grammar to the derivation provided when the assumption of underlying structure is allowed. The example will be the passive construction in English; the Brainian derivation will be given first, then the derivation in generative grammer (based on Bever et al., 1965a.).

In Braine's grammar, a sentence like <u>the dog is chased by the boy</u> is derived form <u>the boy chases the dog</u> by the rule stated in (1):

(1) NP_1 V NP_2 becomes NP_2 is V + ed by NP_1

Accordingly, one might suppose that (2), another declarative sentence, could be converted to the passive by the same rule, but instead the outcome is the non-sentence (3).

(2) The boy chases the dogs

(3) *The dogs is chased by the boy

Thus a modification must be made in the original rule. It is written here as (4a) and (4b):

(4a) NP_1 V Np_2 + sg becomes NP_2 is V + ed by NP_1

(4b) NP_1 V NP_2 + pl becomes NP_2 + S are V + ed by NP_1

But now consider the following sentence:

(5) The boy is chasing the dog

Applying the rule (4a), we obtain another non-sentence:

(6) *The dog is is chasing ed by the boy

Hence, two more passive rules are required for declaratives in the progressive tense, one for singular and one for plural objects. Only the singular rule is written here.

(7) NP_1 is V ing NP_2 + sg becomes NP_2 + sg is being V ed by NP_1,

which when applied to (5) gives the well-formed passive:

(8) The dog is being chased by the boy

And so on. Bever et al. show through these examples (of which 1 through 8 is but a sample) that the derivation of passive sentences from active sentences requires a separate rule for each combination of verb-tense and object-number. If one assumes five tenses and two numbers, altogether 10 different rules will be needed, and this leaves out of account the further rules to form passive-questions (of several types), passive-negatives, etc. In general, one needs a separate passivization rule for each different variant of the declarative sentence. Add to this ascending total the need for further "transformations" to form questions, negatives, embeddings, etc., and the number can be seen to increase geometrically. Braine's grammar provides a structure vastly more complex than English, in fact, presents.

The difficulty is that the rules operate on the surface structure of declarative sentences. As Bever et al. say: "In each of the cases we have discussed, the problem clearly arises from the attempt to derive the passive from its corresponding declarative.", a difficulty that "... would be avoided were it possible to define the transformation which rearranges the subject and object phrases so that it applies prior to the attachment of tense and number to the verb" (1965a, p. 472). The transformation rule possessing this property is highly general, applying to the forms underlying a large variety of surface structures; Bever et al. give it as follows:

(9) NP_1 aux V NP_2 becomes NP_2 aux be + past part V by NP_1.

Other transformations, applied after (9), introduce tense and number.

However, in order to achieve the economy represented by (9), it is necessary to distinguish base from surface structure. Sentences such as <u>the dogs are being chased by the boy</u> must be allowed to have an underlying form so arranged that (9) may apply, and to do so before application of the rules of tense and number. In the case of the sentence just given, the base structure is ((the)(boy sg)(sg)) (((pres be+ing) (chase)) ((the) (dog pl) (pl))) (Bever et al., 1965, p. 473; labeling of brackets has been omitted here). Somehow children acquire linguistic knowledge that can be represented in this form.

Braine (1965) devotes considerable time to an argument that the declarative is untransformed in English, and so could be learned through contextual generalization and restricted association. It is not necessary to debate the merits of this proposal, even though, in fact, there is strong evidence in support of considering simple declarative sentences as transformed (Chomsky, 1957; Bever et al., 1965b). But Braine's argument may be answered simply on the grounds that it poses an impossible dilemma for any theory of language acquisition. If declarative sentences were untransformed, there would still remain the problem of explaining the acquisition of the base structure of other sentence types, for example, the passive. Accepting Braine's proposal, therefore, would merely have the effect of isolating declarative sentences from the rest of English grammar. Thus one either reformulates the grammar of English in ways demonstrably unacceptable, or one removes certain sentences from English grammar and accounts for them as non-grammatical entities. It is the application of S-R principles that forces Braine into this dilemma and it is a measure of the general inapplicability of S-R theory that neither alternative is relevant to the problem of language acquisition.

Let us attempt a brief summary. It was argued that the notion "language" must itself be specified before a theory of language acquisition can be formulated. This requirement is inescapable. To do otherwise is to practice self-deception, for unstated assumptions about the nature of language are necessarily being maintained. It was then argued that for two views of language acquisition derived form S-R theory, namely, Jenkins and Palermo's and Braine's theories, the assumption is that English possesses a phrase-structure grammar. A mass of linguistic evidence shows this assumption to be incorrect, so we must conclude that neither theory is appropriate to the problem of language acquisition. Moreover, it appears that these theories must fail in principle, inasmuch as S-R theories (according to Chomsky's and Fodor's arguments) restrict learning to the acquisition of overt responses, at least initially, whereas languages with transformation rules require the acquisition of underlying forms that are never presented overtly in speech. Thus, we arrive at the general conclusion that S-R theory cannot yield a theory of the acquisition of grammatical competence, if by this is understood a transformational grammar. The basic assumptions of S-R theory are inappropriate to the problem because the theory assumes the existence of overt S-R contingencies, a condition that language fails to meet. The next section considers theories that avoid the imposition of this condition.

Nativist Theories of Language Acquisition

It goes without saying that no theory currently available, nativist or S-R, can account for the acquisition of language. The advantage of the theories to be considered next is that they are not refuted on principle; however, it certainly cannot be said that they explain the acquisition of language in any definite or clear way. One merit of nativist theories is that they attempt to make explicit the sense in which man is the only animal in possession of language. The general point of view is that children are endowed with a biologically based capacity for language. Stated so simply, of course, this is not a particularly interesting hypothesis, for it merely restates the observation that man is the only articulate creature. To make the hypothesis interesting it is necessary to show what the specific features of this capacity might be. On this, some definite suggestions can be made.

Chomsky (1965), Katz (1966), and others as well, have argued that the specific content of a child's capacity for language is manifested in the form of linguistic universals. These are features that define the general form of human language and so appear in natural languages everywhere, regardless of physical or cultural setting. A brief review of their argument will set the context for what follows.

One may think of the problem of language acquisition as being essentially the same as the problem faced by linguists in evaluating grammars written for particular languages. In writing a grammar, a linguist hopes to reconstruct the tacit competence possessed by fluent speakers of the language. A child hopes to become such a speaker, so he, too, must reconstruct the competence of fluent speakers, that is, he must formulate the grammar of the language to which he is exposed. One method a linguist has for evaluating the accuracy of a grammar is to become a fluent speaker himself and test the formulations of the grammar against his own intuitions. A child, however, cannot do this. He cannot evaluate the grammar that he supposes to underlie the language he overhears by first becoming a fluent speaker and then judging the grammar against his intuitions. It is acquisition of the grammar in the first place that poses the problem. A child must evaluate proposed grammars by a different method, and this, too, corresponds to a method of evaluation available to linguists.

In addition to testing a grammar against the intuitions of a native speaker, a linguist may use linguistic theory to select one grammar from a set of candidates, the selected grammar then representing the competence of native speakers The selection is based on the existence of various linguistic universals. Evaluation conducted in this manner leads to what Chomsky (1965) calls "explanatory adequacy", which is obtained when linguistic theory gives a <u>principled</u> basis for accepting one representation of the grammar of a language over other possible representations.

A grammar descriptive of linguistic competence is explained when it can be derived from linguistic theory. It is in this sense that linguistic theory is a hypothesis about the general form of human language.

The acquisition of language by children can be regarded in the same way. If the terms of linguistic theory were available to a child, he could make a principled choice of a grammar and thus become a fluent speaker of the language to which he is exposed. According to the arguments advanced by Chomsky and Katz, this is precisely what a child does, because linguistic theory describes his inborn capacity for language. Such a capacity thus can be represented by the set of linguistically universal statements that are organized into linguistic theory. Acquisition of language can be regarded as the guided (principled) choice of a grammar made on the basis of this capacity, a choice ultimately consistent with the evidence of the corpus of speech provided by the mature speakers to whom a child is exposed.

Linguistic theory is under development and is far from complete. Linguists cannot yet make principled choices of grammars. Nonetheless, it is fairly clear what some of the universal statements in linguistic theory will be. They will include such matters as the formal distinction between rules of formation and transformation; the distinction between base and surface structure; the definitions of the various grammatical relations, such as subject-predicate, main verb-object, and, possibly, modifier-head; plus many more. Some comment will be made below on each of these, particularly the last set--the basic grammatical relations. First, however, it is necessary to clarify two implications of these proposals of Chomsky and Katz. How does this theory account for the acquisition of abstract features, and how does it account for the speed of acquisition?

As to the first question, the answer is that it is badly put. The question should be instead: Why do languages have abstract features at all? The answer to this revised question is that children place them there. It is possible for languages to contain abstract features because these features correspond to aspects of children's inborn capacity for languages. The general notions of base structures and transformed surface structures are included within linguistic theory. This decision is required by many linguistic considerations, and does not depend on the effort to formulate a theory of language acquisition. The implication for language acquisition is that children initiate their linguistic careers with base structures and thereafter acquire particular transformations. Base structures become abstract in the course of acquisition; they do not begin that way.

This implication provides an answer to the second question--how does the theory account for the speed of language acquisition? The supposition is that the abstract features of language corresponding to linguistic universals develop very early, around 18 months or two years. If it should be otherwise, an inborn capacity for language acquisition could not contribute to the speed of acquisition. However, if it should be the case that children display universal features in their earliest grammatical productions, then one hypothesis--that these features reflect a child's biological endowment--can account for both the speed of acquisition and the ultimate abstraction of what is acquired. Some evidence in support of this hypothesis is presented in the next section.

<u>The basic grammatical relations</u>. The basic grammatical relations are the concepts of subject and predicate of a sentence; main verb and object of a verb phrase; and modifier and head of a noun phrase. They are defined in linguistic theory as configurations of the base structure of sentences

(Katz & Postal, 1964; Chomsky, 1964). The subject of a sentence, for example, is the NP directly dominated by S in the base structure. The predicate of a sentence is the VP directly dominated by S (or, alternatively, dominated by Pred P--the difference will be ignored here, but see Chomsky, 1965, for discussion). The object of a verb phrase is the NP directly dominated by VP, whereas the main verb of a verb phrase is the V directly dominated by VP. Although not mentioned in the references cited, the modifier of a noun phrase will be taken to be some kind of determiner directly dominated by NP, whereas the head of a noun phrase will be defined as the N directly dominated by NP. These definitions appear to be universal. All languages possess the configurations necessary to apply them, and so the definitions themselves are entered in linguistic theory.

The configurations to which these definitions apply are located in the base structure of sentences, not the surface structure, because of sentences like John is easy to please and John is eager to please. The surface structures of these sentences are the same, yet the word John stands in two different grammatical relations--object in the first, subject in the second. The base structures, in contrast, differ precisely in the configurations relevant to the definitions of subject and object. Thus, the definitions hold for base structures but not for surface structures. They are "abstract" in the sense used above.

Are the basic grammatical relations included in the earliest patterned speech of children? One indication that they are comes form a child exposed to English, a little boy called Adam by Brown and Bellugi (1964).

At the time his speech was first recorded, Adam appeared to have three grammatical classes--verbs, nouns, and pivots. The evidence for distinguishing these classes was distributional: English verbs had privileges of occurrence in Adam's speech different from English nouns; Adam's pivot class had a third privilege of occurrence, but it was grammatically heterogeneous from the point of view of English.

A little arithmetic shows that with three grammatical classes, N, V, and P, there are $(3)^2 = 9$ different patterns two words long and $(3)^3 = 27$ different patterns three words long. If a child were combining words at random, all (or nearly all) these 9 and 27 different combinations should occur. However, not every combination is a direct (i.e., a nontransformed) manifestation of one or another basic grammatical relation. Only four of the 9 two-word possibilities directly manifest one or more of these relations, the remaining five being inadmissible from this point of view. A direct manifestation would be N + V (e.g., Adam run), corresponding to the subject-predicate relation. An inadmissible combination would be P + P (e.g., my that). Among the three-word combinations, only eight directly manifest one or another basic grammatical relation, the remaining 19 being inadmissible. An example of a direct manifestation is V + N + N (e.g., change Adam diaper), corresponding to the verb-object and modifier-head relations, whereas an inadmissible combination would be V + V + N (e.g., come eat pablum).

Examples of every possible direct manifestation were contained in the first three samples of Adam's speech that Brown and Bellugi collected. In itself, this result is not surprising. Altogether, some eight hours' recording were involved, and some 400 utterances from Adam. If the child were placing words together on some principle that allowed most of the possible combinations, those directly manifesting the basic grammatical relations would be expected on grounds of the large sample size. However, all 400 of Adam's sentences were of this type. There were no others. Thus, although change Adam diaper might have occurred, come eat pablum did not. For details, see McNeill (1966).

That this should be the outcome is certainly not obvious, a priori. In fact, one might have supposed that the result would have been different. Superficially, adult speech contains many examples of inadmissible sequences of Adam's grammatical classes. For instance, the sentence-type represented by come and eat your pablum is common enough. To judge from some of Braine's (1963a) experiments with artificial "languages," people find it difficult to avoid acquiring patterns to which they are exposed, even when told that the patterns do not exemplify what they are to acquire. If we assume that the same sensitivity holds true of young children, then some explanation must be offered for the fact that Adam did not produce sentences like come eat pablum after hearing examples like come and eat your pablum in parental speech. One explanation is that Adam limited himself to sentence patterns that directly express the basic grammatical relations. An adult sentence like come and eat your pablum is a complex construction involving several transformations not yet part of Adam's competence. Adam, attempting to express the basic grammatical relations but lacking the appropriate transformations, would be unable to produce sentences of this type even though examples had been given to him. Thus, not only is there evidence that children attempt to include universal linguistic features in their earliest speech, but also that the variety of sentence types in child speech is strictly limited by the set of available transformations. If these observations are correct, then the order of development for Adam was from some kind of universal base structure to English surface structure, as would be the case if acquisition proceeds through the addition of particular transformations to a foundation given by an inborn capacity for language. A similar conclusion is reached from an examination of the early speech of children acquiring Japanese.

I have recently begun collecting samples of speech from two children who live in Tokyo. Each child is visited twice monthly in her home at which time everything said by the child is tape recorded. Both children are girls; both are approximately two years' old as of this writing. Neither is especially far advanced in acquiring Japanese, and from one, exactly 17 word combinations have been recorded during the past three months. The second child, however, produces large quantities of patterned speech, and the evidence described below comes from her. In the interest of maintaining the tradition begun by Brown, this child will be called Izanami, after the goddess of Japanese mythology who helped create the world.

In certain respects, Japanese is particularly revealing for the study of language acquisition. It is a postpositional rather than a prepositional language. Very roughly, postpositions are comparable to prepositions in English, although not all English prepositions can be translated into Japanese postpositions, and conversely. Among the postpositions that have no English equivalents there are two that obligatorily mark, in the surface structure, the grammatical subject of the sentence.

The two subject markers are _wa_ and _ga_. Although both follow the subject NP of a sentence, they are not identical, and receive different analyses in a transformational grammar of Japanese (Kuroda, 1965). The differences between _wa_ and _ga_ will be introduced by a few examples, then following Kuroda, they will be characterized somewhat more systematically.

A man-ga is standing on the corner

The man-wa is standing on the corner

Man-wa is mortal

In answer to the question, "which man is sick?", one would reply

That man-ga is sick,

whereas in answer to the question, "who is sick?", one could reply

That man-wa is sick.

A person, naming some object, would say

This-wa is a digital computer,

whereas hearing someone refer to the coke machine in the corner as a computer, one would correct him by saying

This-ga is a digital computer.

The distributional similarity of wa and ga is as close in Japanese as in these English examples, so that what is presented to a child in parental speech will not distinguish them. However, as the examples indicate, wa and ga play very different grammatical roles. Subjects of sentences that state general truths, subjects that have attributes given to them by the predicate, subjects that function like the logical premises of judgments, and words like this and that when they are used in definitions, all take wa. Quite often, wa can be translated into English with the expression "as for...". In each case, an attribute (standing on the corner, mortality, computerhood) is judged applicable to the subject of the sentence. Kuroda calls this usage "predictional judgment".

The postposition ga differs from wa in two ways. In one sense, ga is used in description. Instead of the predicate of the sentence being a property judged attributable to the subject, the subject and predicate stand in some roughly equal relation to one another. They are linked in a connection always felt to be momentary, presumably because the subject marked by ga is always an arbitrary member of a generic category, as in a man is standing on the street corner.

The second use of ga excludes possibilities from a known set of alternatives. In this sense of ga, information is conveyed not only about the subject of the sentence, but also about the members of the set of alternatives not mentioned in the sentence. Thus, to use one of Kuroda's examples, if three people, John, Bill, and Tom are lying side by side in three beds, and a doctor arrives asking, "who is sick?", the answer John-ga is sick means not only that John is ill but, in addition, that Bill and Tom are well. Heavy stress often conveys this meaning in English--"John is sick." The corresponding sentence with wa conveys information about John alone. If the reply is John-wa is sick, meaning "as for John, he is sick", nothing is learned about the state of health of Bill or Tom. The vaporous quality of much Japanese philosophy may exist because of this postposition, wa.

To turn now to the acquisition of Japanese, the occurrence of wa and ga in the appropriate places would signify that Izanami, like Adam, is expressing the basic grammatical relation of subject. The transformations that introduce these postpositions into the surface structure of Japanese sentences apply to a configuration in which an NP is immediately dominated by S. Unless the necessary configuration is part of Izanami's competence, there would be no basis for her to fomulate the transformation, so wa and ga should not appear.

What of the distinction between wa and ga? Izanami's mother uses wa twice as often as she uses ga. Presumably this would favor acquisition of wa. Moreover, wa is involved whenever the mother introduces new vocabulary, describes permanent states and general truths, or attributes properties to objects. We can be certain that Izanami understands such sentences from her mother. They are the principal means through which the child receives new vocabulary and information, and there is no doubt that Izanami acquires both. For these reasons, we might expect wa to appear.

The mother uses ga both in descriptions of transitory states and in the exclusion of alternatives from a known set. It is not clear what to expect Izanami to do with the descriptive ga. One assumption often made is that children discover grammatical relations by noting enduring relations in the physical world--for example, the names of objects, or the relation of agent to action, as in the fact that people walk, children cry, houses stand, etc. If this is what children do, one would not expect ga to be acquired early. Ga is never used when these conditions prevail; wa is the required postposition. On the other hand, Kuroda comes to the conclusion that wa, although it marks the subject of a sentence and never co-exists with ga, nonetheless represents an essentially different concept, one added to the notion of a grammatical subject. This would suggest that ga only should appear, since the circumstances appropriate to wa present information falling outside the conceptual content of the relation of subject to predicate. The exclusive use of ga, because it requires a child to hold alternatives in mind and to exclude all but one, ought not to be acquired early.

The facts are as follows. Izanami uses only one of these postpositions, and it is ga. In eight hours of recorded speech, there were approximately 100 occurrences of ga and six occurrences of wa. All occurrences of wa, save one, were with the same word. Moreover, about one-quarter of the occurrences of ga were of the exclusive type, as in this one-ga I like and the airplane-ga I prefer.

In short, Izanami sharply distinguishes wa from ga, despite the distributional similarities of the postpositions in parental speech, selecting the descriptive use of ga as the principal concept to be encoded. It is clear from this fact alone that she is not working solely from the surface cues available to her, since on this basis wa and ga are virtually indistinguishable. Ga is included almost whenever called for in her speech, whereas wa is almost never supplied when required. Ga never invades contexts calling for wa. Evidently, Izanami knows the transformation that introduces ga.

Izanami's sentences at the present stage of development are mostly two, three, and four morphemes long, which means that she is still in the earliest phase of producing patterned speech. Hence, there is support here for the proposal that children attempt to express the abstract relation "subject of" in their most primitive grammatical efforts, confirming what we have already seen in the speech of Adam.

The child's use of ga and her exclusion of wa clarifies the cognitive implications of the effort to express the grammatical relation of subject. The conceptual correlate of this relation is the linkage of subject and predicate in momentary discription. It is not the discovery of enduring relations between agents and actions in the physical world, nor is it the kind of relation involved in the application of names to objects. Indeed, on Izanami's evidence, naming appears to be completely separate from grammatical development, since appellation in Japanese requires wa, which Izanami invariably omits, although naming of objects is common in her speech. If grammatical development were somehow connected to the development of names, Izanami's postposition would be wa.

The conceptual content of wa thus appears to lie outside a child's attempt to express the subject relation. It is important in this connection to recall Kuroda's conclusion that wa represents a concept added to the notion of a grammatical subject. The situations that call for wa do not represent to a child the basic grammatical relation of subject (if by this, we now mean momentary description), even though it is a grammatical subject that should be marked. This would seem to be very strong evidence of a child's predisposition to produce speech in only highly specific ways.

There remains the problem of Izanami's use of the exclusive ga. It appears to indicate that she can hold in mind several alternatives at once, select one of the set, and simultaneously exclude the rest. Presumably, children are not able to perform this mental operation until age seven or eight (Bruner & Olver, 1966), so its appearance in Izanami at age two occasions some surprise. It is possible, of course, that the linguistic evidence should be interpreted at face value. However, there is an alternative explanation. According to at least one Japanese informant (Nobuko B. McNeill), ga in its non-descriptive use represents not only exclusion but also subjective certainty. Apparently one can easily tell the self-confident from the timorous in Japanese debates by noting who uses ga and who uses wa. The ga-sayers are the self-confident ones. The Japanese Milquetoast prefers wa. All Izanami's uses of ga in its non-descriptive sense were statements of preferences--this one-ga I like, airplanes-ga I prefer, etc. If we can assume that a two-year-old knows what she likes, perhaps the apparently exclusive use of ga would be explained. Unfortunately, this account is ad hoc because there is no general reason to expect children to express subjective certainty through grammatical means.

In addition to the findings already cited from children acquiring Japanese and English, Slobin (1966) describes a child acquiring Russian who also expressed abstract grammatical features in early speech. Unlike adult Russian, where inflections carry information about the grammatical relations in sentences and word order is highly flexible , the earliest sentences of Russian children lack inflections and are composed in rigid order. This difference can be explained if one assumes that Russian children express abstract structures but lack transformations for introducing inflections. For it is the case, as Slobin writes, that "The most economical representation of an inflected language like Russian would order the language in the underlying representation. Inflections could then be added to the characteristic positions of parts of speech, and an additional rule or rules would then re-order this string" (1965, p. 101).

The basis on which a child builds sentence order may in turn depend on what he believes are the local manifestations of the basic grammatical relations. For the Russian child described by Slobin, sentences were produced in the order subject-object-verb, whereas the statistically predominant order in parental speech was subject-verb-object. There are several ways in which such a difference could arise. In general, the definitions of the basic grammatical relations do not determine the order in which the underlying constituents of sentences appear (and this is one of the idiosyncratic aspects of language). Linguistic theory can offer no guidance to a child at this point, so the underlying order must be discovered from parental speech. It is thus possible that occasional appearances of SOV sentences in parental speech led the Russian child to conclude that SOV is the preferred order. But deviant orders can arise in other ways. Take, for example, the English sentence fragment, hit the ball. In fact, it is a verb phrase, manifesting the verb-object relation. However, to a child who expects the basic grammatical relations to hold in parental speech but who does not yet know the order of constituents in English, the fragment hit the ball is ambiguous. Depending on a child's interpretation of the meaning of the fragment, it can be taken to manifest either the verb-object relation or the subject-predicate relation. If he thinks the fragment means "the ball hit something," then he must analyze it as corresponding to the relation of subject-predicate. Such a child would be expected to produce sentences backwards for a time. As a matter of fact, reversal of constitutents occurs in the early speech of children. One of Braine's (1963b) subjects, for example, produced sentences like allgone shoe, allgone lettuce, etc., which are inversions of the corresponding sentences in adult English. It is possible that the Russian child's SOV order also arose from such initial ambiguities in parental speech.

We have three indications that children include universal linguistic features in their earliest patterned speech, and do so before they have acquired many of the transformations necessary for the appearance of adult-like surface structures. They do this in spite of the fact that adult surface structures are the only linguistic evidence received. Since the children are acquiring three different languages, it appears that children do identical things in the face of radically different conditions of learning. The proposal that linguistic theory represents children's inborn capacity for language accordingly gains empirical support. One would expect that the capacity for language is much richer than described here, covering many (though probably not all) abstract aspects of language. Future observations of children engaged in the development of linguistic competence will provide opportunities to evaluate this expectation.

If, for the moment, we accept the proposal that linguistic theory characterizes children's inborn capacity for language, a further question may be (and often is) asked. The question concerns the specificity of this capacity. There is occasionally a feeling that if children do indeed possess specific capacities, the capacities must be specific to something other than language. A common suggestion is that children have a specific capacity to process data in general ways, one outcome of which is linguistic competence (cf. some of the discussion contained in Smith & Miller, 1966). It is difficult to understand the motivation of this proposal inasmuch as it does not avoid the assumption that children have specific abilities, and a specific capacity for language could also play a role in various non-linguistic processes. There remains nonetheless a question as to the extent that language does rest on unique abilities, and something should be said on the implications of assuming that these abilities are not unique.

The argument will be that if the abilities underlying language are not unique to language, then cognition generally must have properties matched by the universal aspects of language. At the very least, cognition must possess the universal features of the base structure, plus the notion of a transformational rule. In addition, cognition would have to include the possibility of recursion in the base structure, as does grammar.

In grammar, transformations relate the surface structure of sentences to an underlying base structure. A very large variety of surface types is reduced to a much smaller variety of base types. The implication of assuming that the capacity for language is a general ability, not one unique to language, is that there is a set of general principles of cognition whereby superficial complexity and diversity are traded off against abstract simplicity and uniformity. In this sense, transformational grammar may provide a model of cognition in general, differing from a theory of cognition primarily in the terminology used.

It follows from this proposal that the variety of abstract types available to cognition is strictly limited--it is to this limited set that all the superficial diversity is reduced. Among the abstract types included, however, presumably would be fundamental methods of combining concepts, corresponding to the basic grammatical relations. The basic grammatical relations, in fact, would be special cases of such fundamental methods of combination.

The present proposal, of course, is highly programmatic and may be seriously in error. Its only merit is to make reasonable the suggestion that language acquisition rests on more general cognitive abilities. Although programmatic, the proposal is open to empirical tests of various kinds. Suggested cognitive abilities can be rejected by showing that they appear in non-linguistic cognitive development after they have appeared in linguistic development. Thus, it would be important to know, for example, if Piaget's (1952) examples of sensori-motor and pre-operational development could be interpreted as the unfolding of a transformational system. In passing, it should be noted that there is no justification for supposing, as sometimes assumed (e.g., McNeill, 1966), that linguistic development is more rapid than cognitive development. For all that we know, the opposite is true--cognitive development is faster than linguistic. Without an analysis of the system acquired in cognitive development comparable to the analysis of syntax, a comparison of the speed of cognitive and linguistic development is simply not possible, since the relative complexity of the two systems is unknown. Further study of a cognitive basis for language acquisition therefore will presumably seek to compare the two realms and note if it is never the case that common features appear in cognition after they have appeared in language.

Footnote

1. I am indebted to Charles Clifton for this observation.

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GROUP C: LANGUAGE MODIFICATION

The modification of behavior takes place in two quite different environments: in the laboratory and elsewhere. In the first site careful control is exercised so that the environment is, in a sense, sterile--free of contaminating variables. From the behavioral laboratories in the past twenty years or so have come an amazing number of powerful techniques and principles, and, importantly, replicable experiments. Elsewhere in the world the modification of behavior must occur under conditions that are complicated, confusing and sometimes antagonistic. The principles that have emerged are grouped under such headings as "common sense"; more elegantly as "interpersonal skills"; and more critically as "Machiavellian machinations." There is minimal control and the results, such as they are, are usually not replicable.

The second language teacher, the speech therapist, as well as other educators and clinicians have heard from the behavioral scientist that major advances are being made in explicating the principles of behavioral modification. The voices they hear are loud, repetitious, and often inspiring. Their own everyday needs amplify the hope raised by the pronouncements of the scientist, and yet, though both parties agree that a bridge must be built between the laboratory and the rest of the world and that applications must be made, only very recently has that bridge been more than a thin verbal strand across which nothing could cross safely.

Group C consists of people who are engaged in the transitional research and development necessary if a stronger structure is to be built, linking basic research and practical needs. Within the area of "behavioral engineering," there is a spectrum of possible research, some parts of which are represented in this and in

CRLLB Progress Report No. II. Thus, George Geis's study of answer-observing in programmed instruction (Progress Report No. II) might be termed a laboratory study, manipulative, and microscopic. The studies of the behaviors of teaching fellows in French classes, reported by Stephen Knapp, Don Dugas, and George Geis, and by Don Dugas, Stephen Knapp, and Cyrus Sisson, can be classified as naturalistic field, macroscopic studies. Naturalistic studies such as these often lead to controlled manipulative studies, such as "Classroom management of a reading program: the teacher's role" reported by Dale Brethower in CRLLB Progress Report No. I, to the development of specific instructional materials (e.g., the video-tape and text programs for teaching fellows), and the explication of future research and development strategies as expressed in the paper by Knapp et al. The construction and updating of the matching-to-sample bibliography by George Geis and Susan Nielsen represent an auxiliary but important interest and function of the group--examining and devising new instruments and techniques of specific interest to the behavioral modifier.

Observations on the Analysis and Control of Teacher-Student Interaction in the Foreign Language Classroom Based on Video-Tape Recordings[1]

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Abstract

Six one-hour sections of an intensified first- and second-year French course conducted by graduate-student teaching fellows were video-taped. These tapes were analyzed in order to determine teaching problems related to teacher-student interactions. The analysis led to specific recommendations for more effective and efficient classroom teaching concerning specification of student terminal behavior, diagnostic testing, strategies of teaching, contingency management, and language skills. A filmed training program, based on the video-tapes, was administered to the teaching fellows.

Since classroom instruction is the primary medium for most foreign language courses, the evaluation and modification of classroom instruction require a method of analyzing, classifying and measuring the behavior of students and teachers in the classroom. This, in turn, requires a technique for observing and recording classroom behavior. The present study is an exploration of one such technique, video-tape recording, which appears to offer as objective and complete a means for observation as any other available.

Method

The classes studied were in the University of Michigan "Pilot Project" for first- and second-year French. "Pilot French" was an intensive study program in which the students took the equivalent of two semesters' work in a single semester. The daily routine for each student was lecture in the morning, work in the language laboratory after the lecture, and a final class period in which about eight students practiced new patterns under the supervision of a teaching fellow. With the cooperation of the English Language Institute, the Universtiy of Michigan Television Center, and the Michigan Bell Telephone Company, each of the six teaching fellow's sections was video-taped in a specially-designed classroom, and then a filmed instructional program was prepared from these recordings.

In the classroom, one remote-control television camera focused on the students (sitting in tiers) while a second camera (at the back of the room) filmed the teacher (standing at the front of the room). Two directional microphones were suspended from the ceiling. The cameras were operated from another room, where the view from one or the other was recorded by means of a switching system operated by E, since only one camera at a time could be used to record.

Each class met twice in this classroom with all equipment present; once in order to acclimate the students and teaching fellows to the novel environment; again, a week later, in order to make the recordings.

The tapes were viewed and edited by the authors, with the help of consultants. Representative examples of the problems observed were chosen from the six hours of video-tape. In many cases, it was possible to find related examples of what were judged good and poor teaching techniques, and these were juxtaposed in the edited film prepared from the tapes. In some of these oppositions the use of only one behavioral principle was contrasted, e.g., immediacy of confirmation; other oppositions were more complex. The set of oppositions was sequenced according to a preliminary instructional program.

After previewing the instructional film, the authors devised a short paper-and-pencil program to enable the teaching fellows (the same ones who appeared in the film) to discriminate the criterial features of the filmed oppositions.

Since the emphasis of the training program was on the interactions of student and teacher behaviors, the program taught recognition of the stimulus-response-consequence patterns in the examples.

Four hours were then spent examining this training sequence with the teaching fellows. First, the S-R-C program was administered, followed by the viewing of the film, presented in short segments. Each segment contained as far as possible, a positive and a negative example of one aspect of the teaching situation. Most segments were followed by a discussion among the teaching fellows of certain questions relevant to the examples; because of the length of the film and the amount of discussion only the first twenty of the thirty oppositions were followed by discussion.

Results and Discussion[3]

Malpractice in contingency management

The video-tapes revealed certain situations that, from a behavioral point of view, were not desirable, and indeed were probably detrimental to learning. Many of these involved managing the consequences of student behavior. For example, an aversive situation sometimes was produced by a correct response, effectively punishing it. In one case, a student who was having obvious difficulty in producing a correct response was "reinforced" for his correct response with the immediate presentation of another problem to which he was unable to respond. In other situations, a correct response by a student was followed by "neutral" consequences, i.e., those which might not be expected to strengthen that response. In many cases where a student emitted an incorrect response, that response was punished, usually verbally. (Nearly all the consequences for student responses were verbal statements by the teaching fellow.)

A technique often used by the teaching fellows was: (1) to present a model (stimulus), (2) to call on a student and, (3) if he responded incorrectly, to call upon a second student. Two objections might be raised to this practice. The first student escaped from the scrutiny of the class and the teacher; also, incorrect responses may have been positively reinforced under this system. The second objection concerns the effective stimulus model for the second student who was probably responding not to the teacher's model but to the incorrect response of the first student. Furthermore, the only way the first student could diagnose his own problems would be by comparing his incorrect response to the response of the second student, assuming, as was not always the case, that the second student had responded correctly.

Another problem was the inconsistency of contingencies. Sometimes, as in the above case, the student received no feedback, positive or negative, to govern his future behavior. Although a student sometimes received feedback for an incorrect response, he less frequently received it after a correct response. Moreover, the feedback was sometimes informative and at other times merely indicative of the occurrence of an error.

Further doubts may be raised concerning the nature of the "reinforcers" employed. It could not be determined whether certain consequences increased the probability of the responses that produced them. Until these consequences are thus demonstrated to be reinforcers it cannot be assumed that such consequences as the teacher saying "Bon!" and "Tres bien!" are reinforcers.

Malpractice in stimulus control

Not only was it possible to state behavioral problems existing in the classrooms after a careful analysis of the video-tapes, but also a linguistic analysis of teacher and student performances could be made free of the constraints of an observer in the classroom. For example, one segment of the film has been intensively analyzed to the point of preparing visible speech recordings of the phrase chez le docteur, which was a portion of a model that a student was asked to imitate. According to spectrograms, the teaching fellow omitted the article le completely during some presentations of the model, after which the student also left out the article. When this happened, the teacher would counter by over-emphasizing the article le. Figure 1 illustrates the teacher's responses by presenting the cumulative duration of successive occurrences of

Insert Figure 1 about here

the /l/ and the /ə/. A zero slope indicates that the /l/ and/or the /ə/ were not present. Notice that whenever the student leaves out the article, the teaching fellow overcompensates, and the duration increases. (This example points out another interesting observation: the teaching fellow's behavior seems to be under the control of the student's incorrect, rather than correct, responses.)

Other linguistic problems at a contextual level can be observed, as in the example where a class understood le son to be leçon. It was not until the teaching fellow had written the two phrases on the blackboard that the difficulty was remedied.

On the whole, it proved quite artificial, however, to separate linguistic problems from learning problems. For example, in one case a correct verb form was reinforced in the middle of an utterance. This meant that the utterance was broken into at least two parts--everything through the verb form was separated from the remainder of the utterance by a "reinforcement," thus producing an improper juncture in the body of the utterance. In addition, only the first part of the utterance may have been learned.

Limitations on conclusions

There are major limitations on any general conclusions that can be drawn from these naturalistic observations of good and poor teaching. (1) Teaching fellows varied in their French language skills, their teaching skills, and their methods of presentation. Their methods of controlling a class were strikingly different, since some of the teaching fellows depended upon positive controls, while others made extensive use of aversive controls.

(2) The subject-matter varied from class to class; therefore, it was impossible to compare student performances in many respects. The responses emitted by the students varied even in a single class. Some students were required to give more difficult responses than others, and rarely were two students required to give the same response to the same stimulus-complex.

(3) The students were sectioned according to previous performance; thus, students in one class had "B" averages while another class had "D" averages. To add to the problem of analysis, four sections were composed of first-year students, while the other two sections were composed of second-year students. The students' previous schooling in French varied, for some had taken French in high school while others had not.

(4) Often, the teaching fellow provided many added cues for the correct response. While this may be common practice in producing learning, it certainly did not yield data on performance of the student similar to that which would have occurred had those cues been absent. As a result, it was usually impossible to determine if the student had indeed learned the desired behavior.

(5) Another confounding effect, similar to (4), was the lack of diagnostic tools to measure the performance of the students after the class. The use of such tests before and after the class would be valuable in revealing what was learned by each student.

(6) Other inputs also affected objective measures of student performance--the lecture in the morning, the language laboratory lessons, and probably, most significantly, the out-of-class-work that the students did on their own.

Skills required for effective teaching

The study has suggested five major areas of competence for effective classroom teaching. While these are stated in terms of terminal behaviors for teaching fellows, they carry implications for the whole teaching system.

<u>Specification of student terminal behavior</u>. The teaching fellow must specify the final criteria for each response the student is asked to emit, answering for himself such questions as, "How good must the pronunciation be?"; "What form do I want the response to take?"; and "Are alternative forms of the response acceptable?" A valuable technique, often neglected in the classroom, is the reinforcement of successive approximations to the desired response. The need to specify the criterion response at each level of approximation is most obvious when the teacher undertakes to use this "shaping" procedure.

One reason for the previously-mentioned inconsistency of contingencies may well be that the teaching fellows often did not have a clear specification of the responses they were requiring, letting an erroneous response go uncorrected on one pass and forcing the student to correct it on the next.

The teaching fellow and the organizers of the course must specify terminal behavior for each class period. Terminal behaviors should be realistic, i.e., attainable in the time allowed. It is the responsibility of the teaching fellow to insure that each student attains these behaviors.

Terminal behaviors for the course must be explicitly stated. The terminal behaviors must have relevance to the objectives of the course and the real-world skills expected of the students. This Pilot Project French course had departmental final exams, which were inappropriate since a great deal of time in class was spent on oral rather than written skills, while the exams tested mainly reading and writing skills.

<u>Diagnostic testing or probing</u>. In the example previously cited in which the student left out the article <u>le</u>, the teaching fellow made no effort to determine the source of the difficulty. Had he inquired, or probed, into the problem, he probably would have found out that he had left out the article and that the student was indeed responding appropriately. What he seemed to

be treating as a problem of student production was really one involving his presentation of the model.

The probe, as defined here, is a form of on-the-spot diagnosis that locates a specific difficulty and thus allows for a solution. There were, in the video-tapes, many examples of improper prescriptions because the problems were not diagnosed correctly by the teacher.

The second terminal behavior for the teaching fellow, then, is the use of probing techniques to determine the cause of each error, the probe being used only to diagnose the problem, not to cue or give away the correct response.

The teaching fellows should effectively administer and use the results of formal tests of skill. They should answer such questions as: "How far along is the student toward the terminal behaviors of the course?"; "Where is the student having difficulties?"; "What existing behaviors in the student can be used for the next segment of the course?"; "Is the student ready to proceed, or must he have remedial training?"; "Is the teacher meeting the objectives of the course?"; and "Are other elements of the system, such as the textbook, workbook exercises, the language lab, or a program working?"

Tests must be prepared to allow the teaching fellows to pre-test the student, and to test the terminal and sub-terminal behaviors that the system produces in the student.

Strategies. Under this heading are such topics as sequencing material for learning, prompting or cueing, discrimination training, shaping, etc. It includes the procedures or methods that teachers use to insure effective learning.

A logical learning sequence that employs such components as added stimulus control, prompts, discrimination learning, and perhaps some of the principles of mathetical programming (Gilbert, 1962a, 1962) must be explicitly stated at the course level. Particular care must be taken, however, not to lose sight of the terminal objectives, since the above means can become the end, as they probably have in many existing courses of study. The teaching fellow should use a variety of strategies, such as prompting, resequencing, or discrimination training to get the student over a hurdle once the nature of the hurdle is determined.

The authors have identified at least two types of prompts: one which gives an instruction, and another which requires an echoic response to a model. In the latter, the model may be exaggerated, in which case the student's echoic response _should_ deviate from the more realistic utterance. Reinforcement of successive approximations to the desired response might also be employed in this case, as well as in the case where the student is to echo the model _precisely_ and cannot make the grade on his first try.

Management of consequences. The teaching fellow is the human link between the student and the material. He has the reponsibility for how much the student learns. To a large extent he determines the pay-off for learning and for failing to learn. He sets the stage for self-study programs, for the language laboratory, and for the student's behavior in the class.

He performs these duties in part by arranging reinforcement contingencies for student behavior (Addison & Homme, 1966; Homme & Tosti, 1965). How he employs his tools--the reinforcers, the punishers--determines whether the student succeeds or fails. This is an awesome responsibility for a first- or second-year graduate student, or indeed the teacher at any level.

Some relatively simple rules, nevertheless, can be applied in the classroom. The teaching fellow will establish contingencies _before_ entering the classroom, and abide by the rules he has established at all times in the classroom. He will change these contingencies when they do not promote learning, and will retain and improve those that are effective.

The same system of pay-offs should apply to the other aspects of the system, such as the language lab. For example, students in this study often did not use the laboratory, with the result that the potential worth of the language lab could not be evaluated, and the teaching fellow had to use valuable class time to teach the behaviors that the laboratory should have been teaching.

Language skills. Not all the teaching fellows had the language skills necessary to incorporate the behavior outlined above into their classroom teaching. They could not always accurately discriminate the responses of students, nor could they always present accurate models (or stimuli). The lack of language skills can be viewed in two ways: as a training problem or as a selection problem. The problem might best be solved by applying the teaching procedures discussed above. If this is not feasible, however, and if better selection seems to be the answer, then better screening procedures must be used. Regardless of the nature of the problem, the teaching fellows must have the necessary skills in discrimination and in production to reinforce student behavior and to present stimuli effectively.

Pilot training program

For the purpose of a pilot training program, "contingency management" seemed to be the skill, among the five listed above, most easily trained. (It is realized that without the other skills the program could not be successful.) Although the film concentrated on this terminal behavior, the first three skills were also included in the training film. Language skills were impossible to train in the limited time available.

The training film attempted to make the teaching fellows conscious of the behavior that occurred in the class, rather than the methods they were using. In order to establish this set, a paper-and-pencil program was used to teach the terms "stimulus," "response," and "consequence," and to teach the relationships between them. The success of this program was demonstrated by the teaching fellows' appropriate use of the terms during the discussions of the training film.

Since the semester was about to end, no follow-up study could be carried on to determine the effects of the film on the behavior of the teaching fellows in the classroom. Their discussions during the film, however, indicated that, at least, they were able to talk objectively about the behavior of the class (even in this framework, however, the discussions often turned to traditional methodology in order to rationalize a specific procedure seen in the film).

After the "training session", the teaching fellows reported that this type of program would have been beneficial to them had it occurred earlier. The authors agree with the teaching fellows, with the added stipulation that the program be completely revised and extended into the classroom where in-service training and follow-up studies can be done.

The study reported above has certainly not uncovered the answers to the basic problems: how to describe, evaluate, and change behavior in the language classroom. The authors believe that the answers will emerge only from an extensive manipulative study of the classroom. The present study has suggested, for the teaching fellows, a set of terminal behaviors that act as a guide in designing a training program for them or for designing other teaching systems.

Footnotes

1. Sections of this paper were based upon a paper delivered by the senior author at the annual convention of the National Society for Programmed Instruction, April 1966, St. Louis.

2. The authors wish to express their appreciation to the teaching fellows who allowed us the privacy of their sanctuary--the classroom. Dr. Harlan Lane, Director of CRLLB and Guy Capelle, visiting professor of French, served as consultants on this project.

3. See also, elsewhere in this report, D. Dugas, S. Knapp, C. Sisson, "A Preliminary Analysis of the Time Distribution During Classroom Instruction in a Second Language".

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Geis, G. L., Jacobs W., & Spencer, D. The role of the printed answer in programmed instruction. Progress Report #1, Ann Arbor: Center for Research on Language and Language Behavior, 1965.

Gilbert, T. F. Mathetics: The technology of education. J. Mathetics, 1962, 1, 7-74. (a)

Gilbert, T. F. Mathetics: II. The design of teaching exercises. J. Mathetics, 1962, 1, 7-56. (b)

Homme, L. E., & Tosti, D. T. Contingency management and motivation. N.S.P.I. J. 1965, 4, 14-16.

Figure Caption

Fig. 1. The cumulative duration of /l/ and /ə/ in le of chez le docteur is plotted as a function of successive utterances by the same teaching fellow. The symbols indicate the nature of the student's response following each utterance.

● means there was no student response.

▲ means there was a correct student response. (chez le docteur)

■ means there was an incorrect student response. (chez docteur)

A single student was used.

______ represents the plot for /l/

------ represents the plot for /ə/

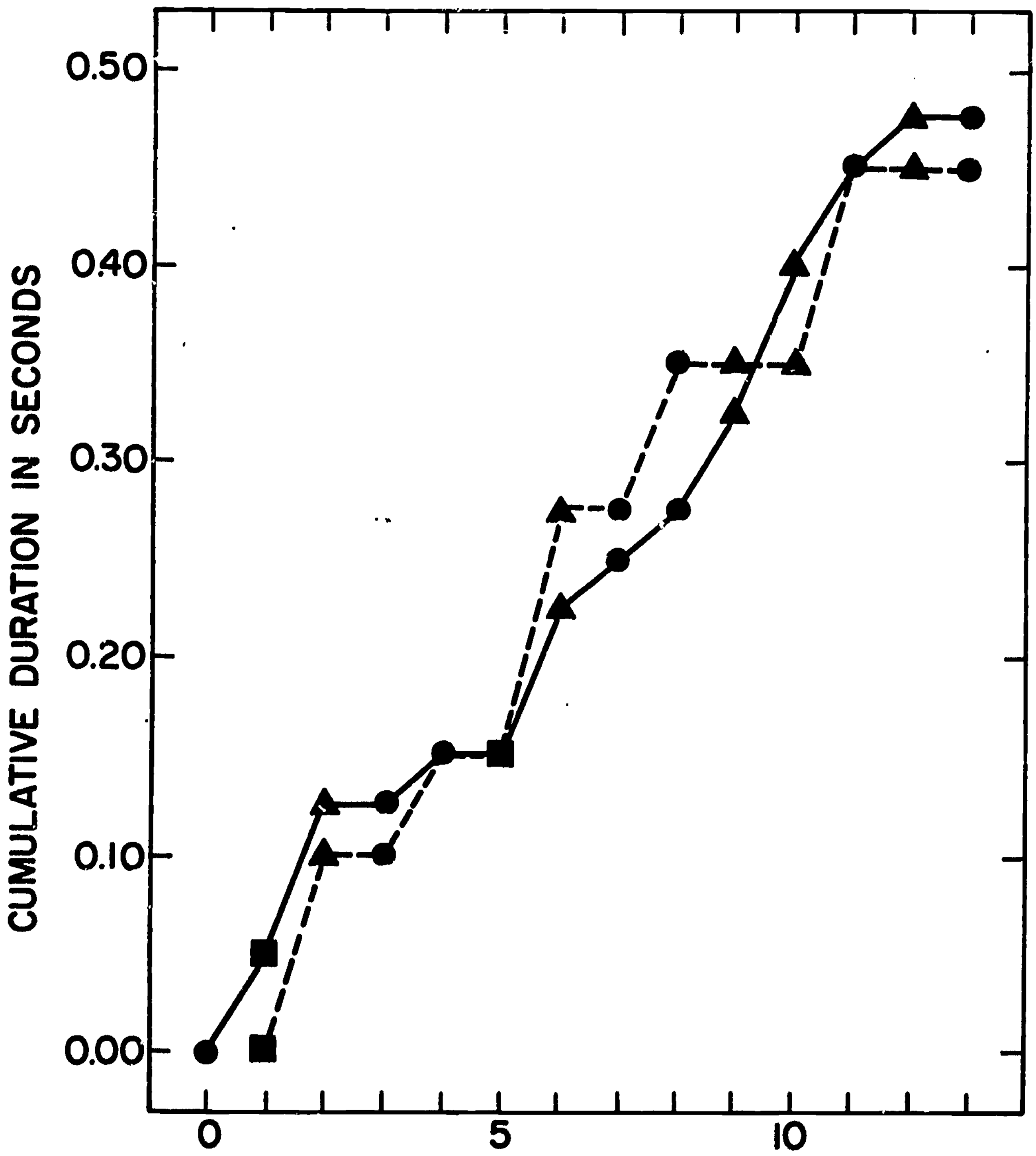

Fig. 1 SUCCESSIVE UTTERANCES BY TEACHER

A Preliminary Analysis of Time Distribution

During Classroom Instruction in a Second Language

Donald Dugas, Stephen F. Knapp, Cyrus R. Sisson

Center for Research on Language and Language Behavior

Abstract

Six different classes of elementary college French were recorded on video tape. The teachers' utterances were classified in five molar categories: model, prompt, correction, confirmation, and other utterances. The amount of time each teacher spent in each of these and other activities was calculated. A count was also made of the time students used in speaking, both individually and in chorus. Uniformities and differences in the distribution of types of activities in the classes are noted. Lines of further research on these variables are suggested.

In December of 1965, six different classes of an introductory French course, each one taught by a different teaching fellow, were video-taped in the television classroom of the English Language Institute. No attempt was made to impose any restrictions on either the teacher or the students, and the filming techniques, described elsewhere in this report[1], eliminated the necessity for an observer to be present in the classroom. Although the resultant recordings were primarily intended for use in the preparation of a training film for later groups of teaching fellows, they were also intended for use in the development of an objective method for analyzing classroom interaction. Few attempts have been made to study the student-teacher relationship in the foreign language classroom in other than real time. It was hoped that two additional developments besides the training film might be forthcoming from this research.

One goal was the establishment of useful techniques for the recording and analysis of this classroom interaction. A second target was to obtain certain preliminary data pertaining to the distribution of the instructor's speaking time over several molar categories such as lecturing, correcting, and presenting models. These categories are described below. Briefly, then, this part of the study is descriptive and propaedeutic to the manipulation of more molecular classes of behavior in the analysis of language learning.

Before describing the procedure used, note should be taken of some differences among the classes. The number of students varied from class to class, as did their academic level (first or second year French). The nature of the lessons ranged from those dealing with specific topics to classes of general review. In one class, students spent some time writing sentences on the blackboard, although the classes usually emphasized the development and improvement of oral skills. Some teachers relied heavily on the technique of choral responses as a teaching vehicle, while in other classes teachers called for individual responses only. Although there were many such differences, the method of analysis was intended to permit evaluation of all of the various classroom situations in which speaking played a significant role.

Method

Processing of the recordings

After the recordings were completed, each one was reviewed and every utterance was timed by manually depressing a switch controlling one time-line of an events recorder (Esterline-Angus). Two switches were used, one to identify utterances of the teacher, and one for utterances of the students speaking individually or in chorus. After each utterance from the six video tapes had been timed in this manner, the six tapes were again reviewed and each previously timed utterance was identified as to type and speaker. Student choral responses were marked as such, and each individual student response was identified by a number corresponding to the student who had uttered it. Where identification of the student was doubtful, utterances were marked separately.

Categories employed

The teacher's speech was classified into one of five categories. First was the model category in which the teacher presented a pattern that the students imitated or transformed according to previous instructions. An example of this type of utterance occurs in a pattern drill where a student is required to change the verb to the future tense from another verb form expressing futurity. The teacher's model might then be:

Je vais prendre l'autocar à huit heures.

to which the correct response would be:

Je prendrai l'autocar à huit heures.

The second category, labelled prompt contained those utterances in which the teacher attempted to elicit a correct response by repeating a key word, reminding the student of the type of transformation to be made, repeating an incorrect part of the student's response with an obviously interrogative intonation, or using any other prompting technique common to similar classroom situations. The third group, corrections, included any of the various ways in which the teacher provided the correct answer to an improper response. The fourth category, confirmation, covered those utterances by which the teacher informed the student that his reply was basically correct. One of the most common confirming utterances was a simple 'bon' indicating at the same time correctness and approval. The fifth category, other utterances, contained all other remarks about the lesson, such as lectures or explanations by the teacher, directions about how a particular drill was to be done, and general administrative statements relating to the day's lesson, such as oral signals that the students were to answer chorally, and the like.

In many cases, evaluation of the video tapes involved some editing to eliminate those periods of time spent in activities unrelated to the French lesson. Some of these deletions were periods of discussion of future and past tests and their scheduling, periods of other than oral activity such as time spent at the blackboard, lengthy periods of laughter or confusion, and any other discussions unrelated to the day's lesson.

Analysis of data

A count was made of the amount of time spent in each of the activities listed above and these sums were converted to percentages. The sum of these percentages plus the percentage of deleted time was subtracted from the total class time to determine the percentage of time during which there was no talking. Figures 1 - 6 show, in the lower portion, the following percentages of total class time: silent time (ST), the totality of student individual talk time (SI), student choral talk time (SC), model time (M), prompt time (P), correction time (Cor), confirming time (Con), and the remaining time spent in class-related activities (Other). In the upper portion of each of the figures is shown that percentage of SI accorded to any one student, and, if applicable, the percentage of the individual speaking time unidentifiable (?) because the camera was not trained on the student speaking.

Insert Figs. 1 - 6 here

Results and Discussion

In spite of the differences in the constitution and conduct of the various classes, several properties of their temporal distributions are relatively constant. The amount of total speaking time, as distinguished from total class time, is almost uniformly divided into 45 per cent student speaking time, (choral and individual time) and 55 per cent teacher speaking time. Further, the teacher's speaking time is relatively consistently divided into model time

(20%), prompting, correcting, and confirming time (10%), and other time (25%). One difference among teachers is the use of choral response as opposed to responses by individuals, but the nature of the relationship between this difference and differences in class size and lesson is unclear. A major discriminating feature, however, is the amount of silent time. This varies largely according to the length of the pauses in the students' responses before prompting. It also reflects the length of time after a model has been presented by the teacher before a student was selected to respond. In some cases, the instructor would call upon some student immediately after giving the model; in other cases, there would be a period of silent time during which all students were to prepare a response, not yet knowing who would eventually be called upon to answer.

Several questions concerning temporal distribution arise that are not answered in this preliminary study. Subsequent research might well consider the kinds and magnitudes of the various pauses that make up silent time. Class size and lesson type may be varied in order to determine their effects on time distribution. The problem of how exacting a teacher should be in the correction of his students' oral responses might be usefully investigated by an extension of the present method of time analysis using improved video-tape techniques. If these kinds of variables are held constant, on the other hand, it may be possible to discern temporal variables that discriminate well among foreign language classes and that correlate with a criterion of their efficacy.

Footnote

[1]See, elsewhere in this report, Knapp, Dugas, & Geis "Observations on the Analysis and Control of Teacher-Student Interaction in the Foreign Language Classroom Based on Video-Tape Recordings."

Figure Captions

Figs. 1 - 6. Temporal distributions in six foreign language classrooms. Each figure contains the percentages of overall classtime during which no speaking activity took place (ST), during which students spoke (individually-SI, and chorally-SC), and during which the instructor presented models (M), prompted (P), corrected (Cor), confirmed (Con), or verbally presented other classroom related material (Other). In the insert for each figure, the time during which the students spoke as individuals (SI) is further divided into the percentage of SI during which any one of them spoke. All doubtful individual responses are included at the right of each insert (?).

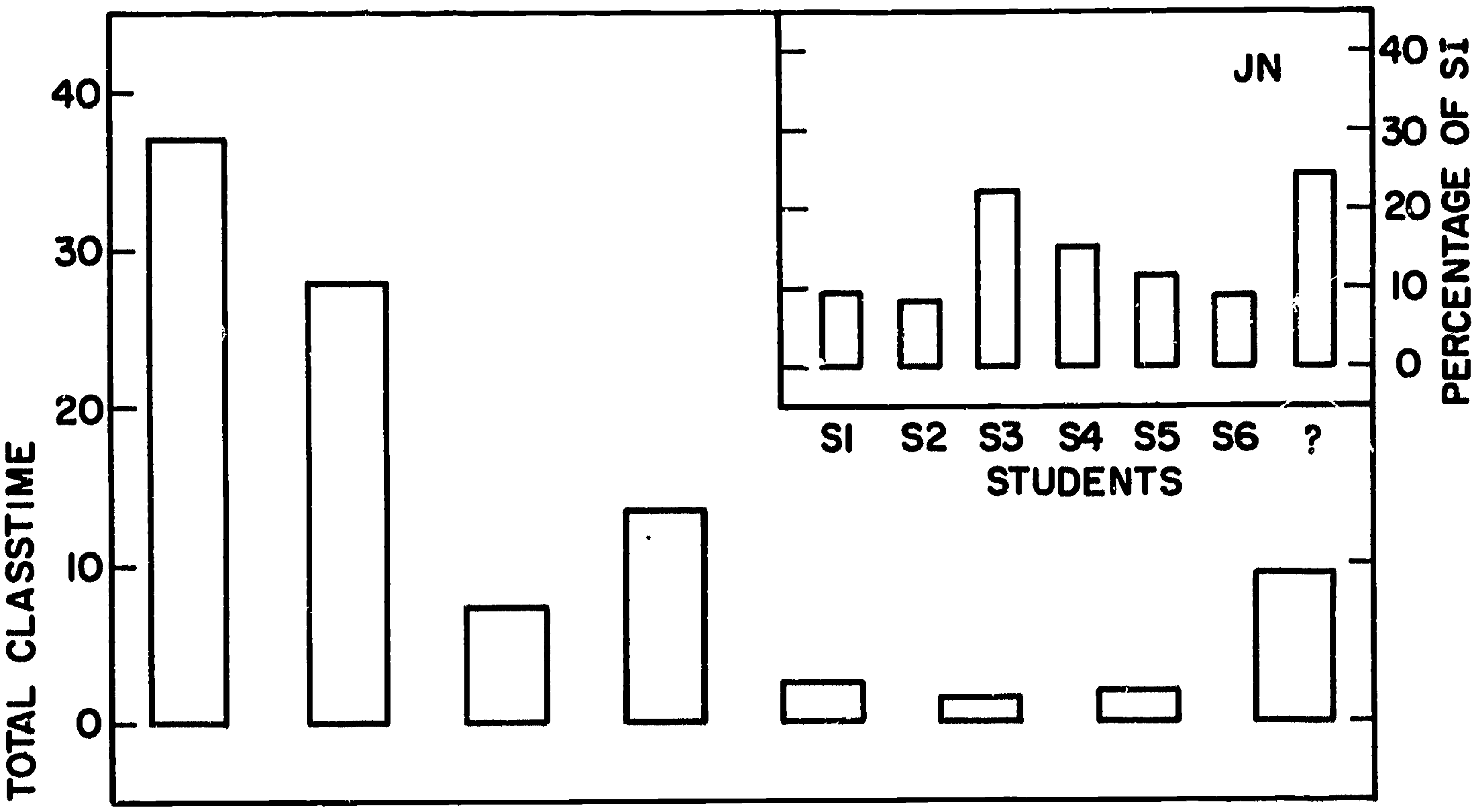

Fig. 1

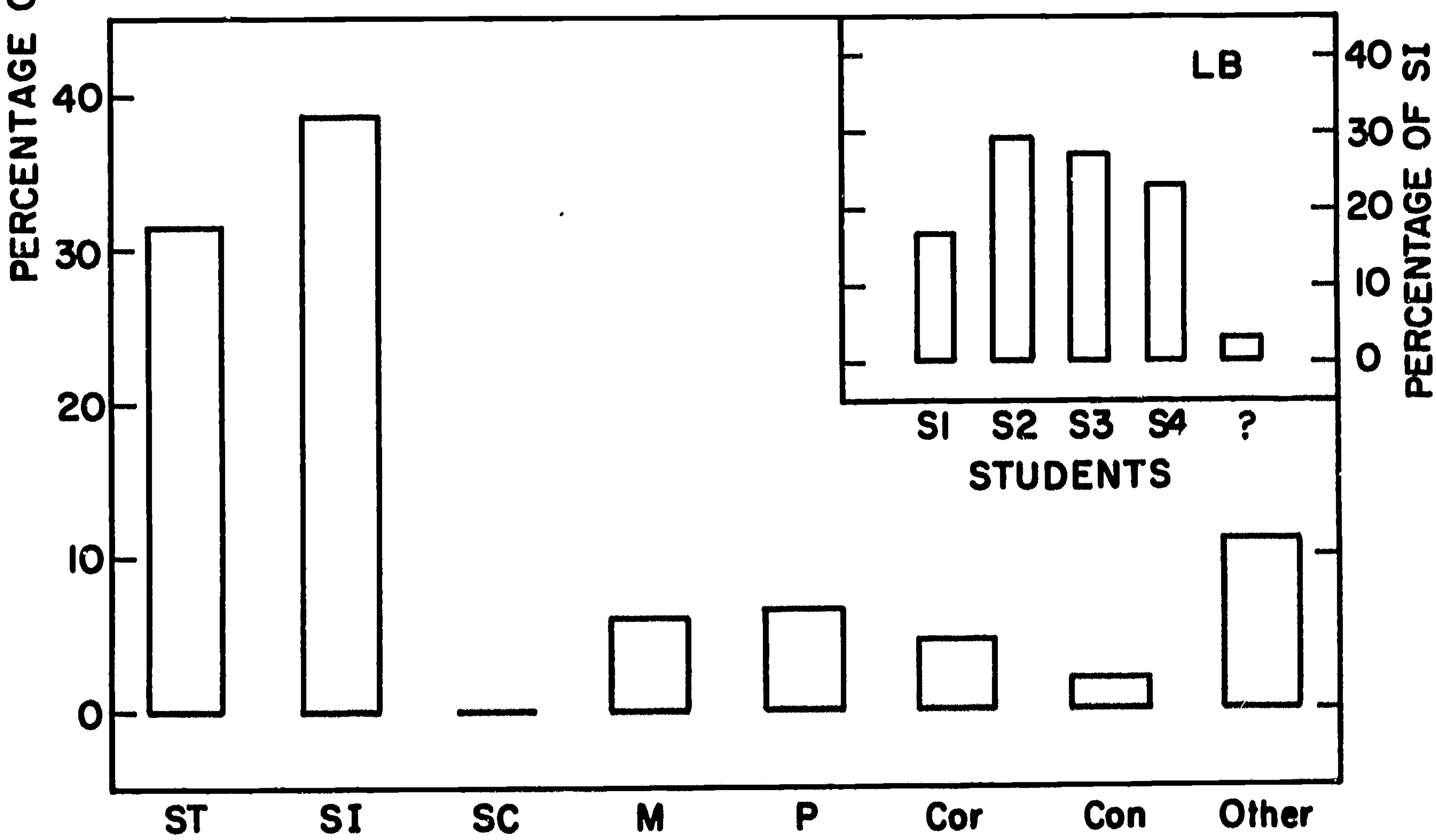

Fig. 2 TYPES OF CLASSROOM BEHAVIOR

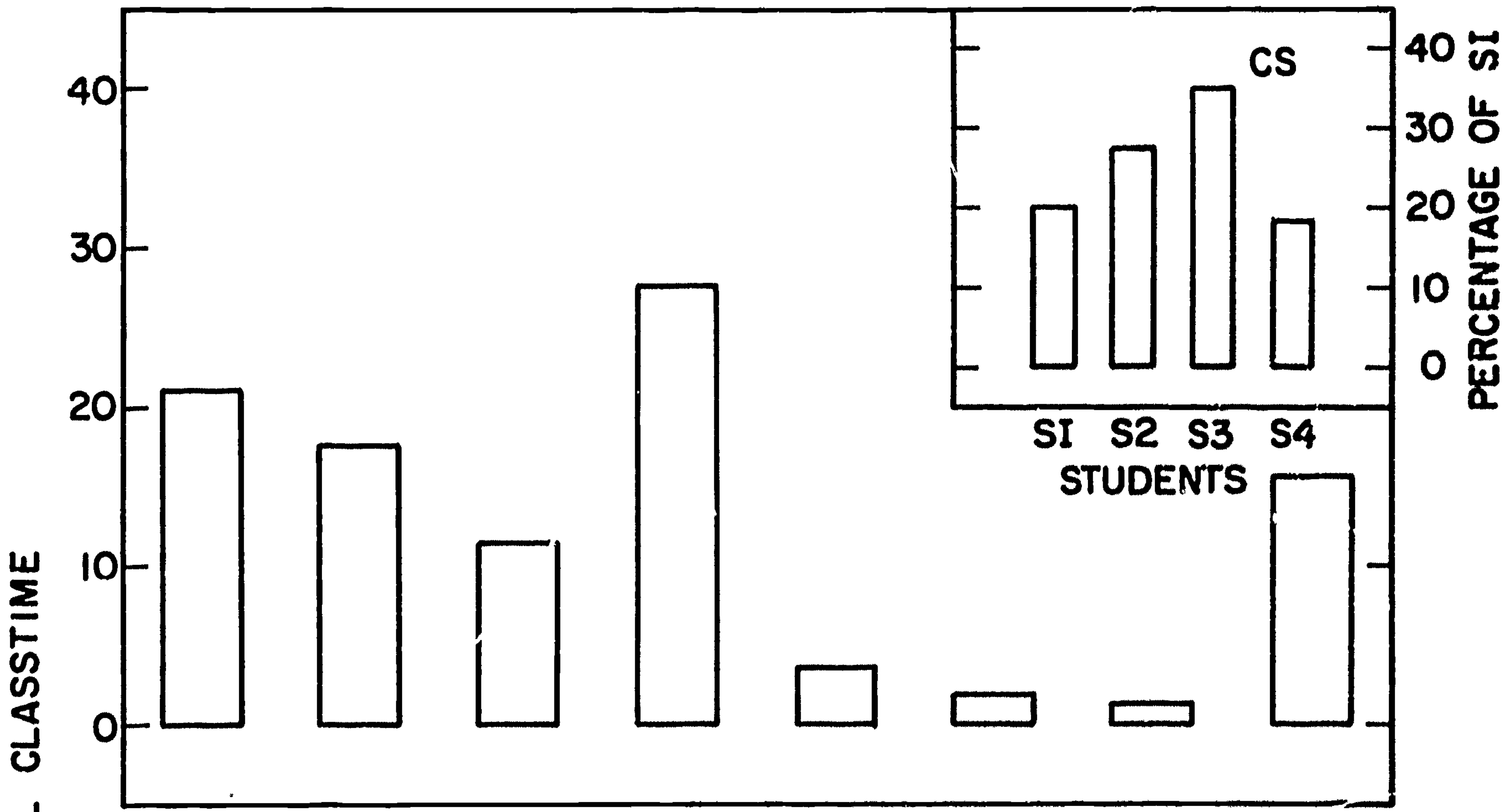

Fig. 3

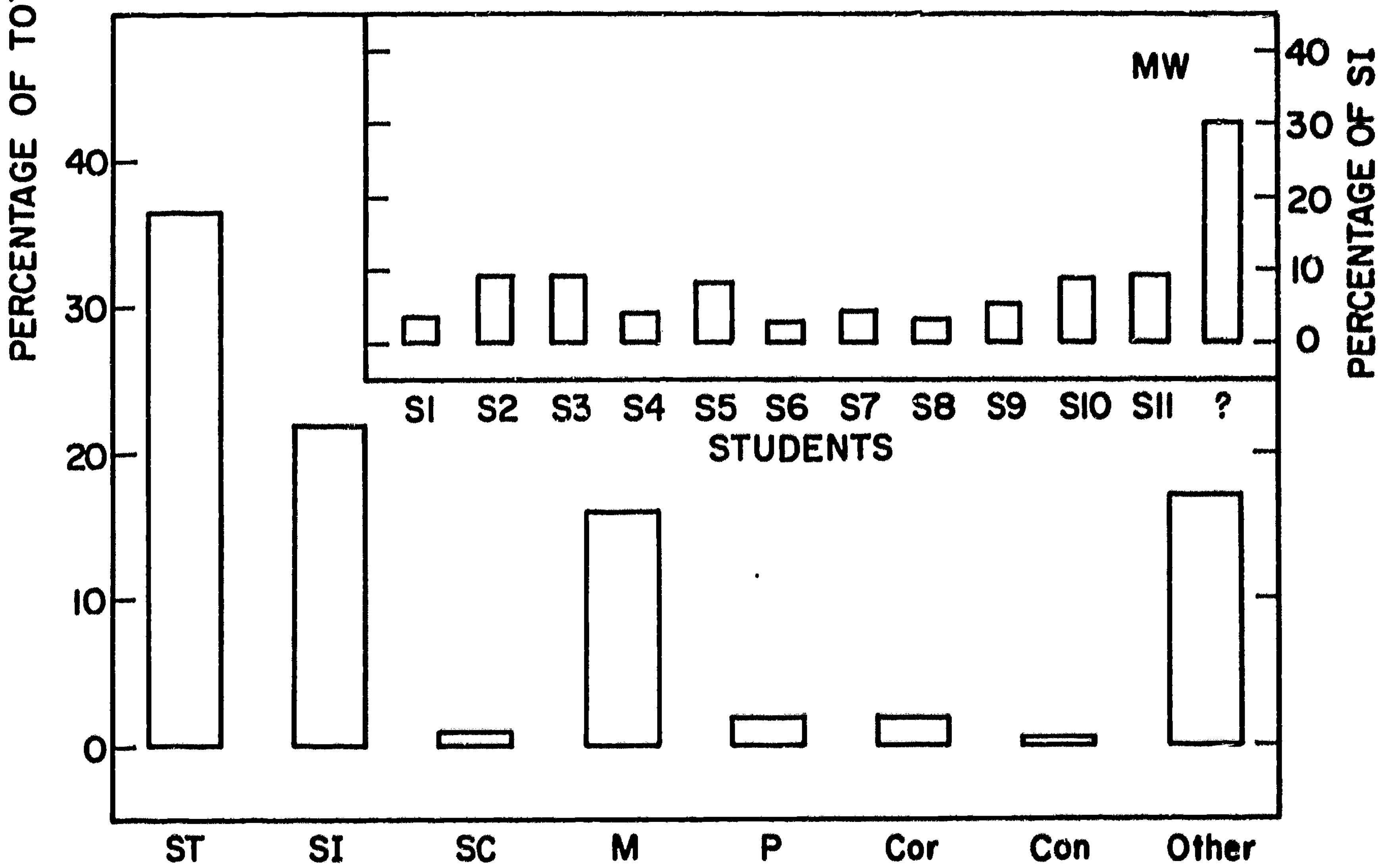

Fig. 4 TYPES OF CLASSROOM BEHAVIOR

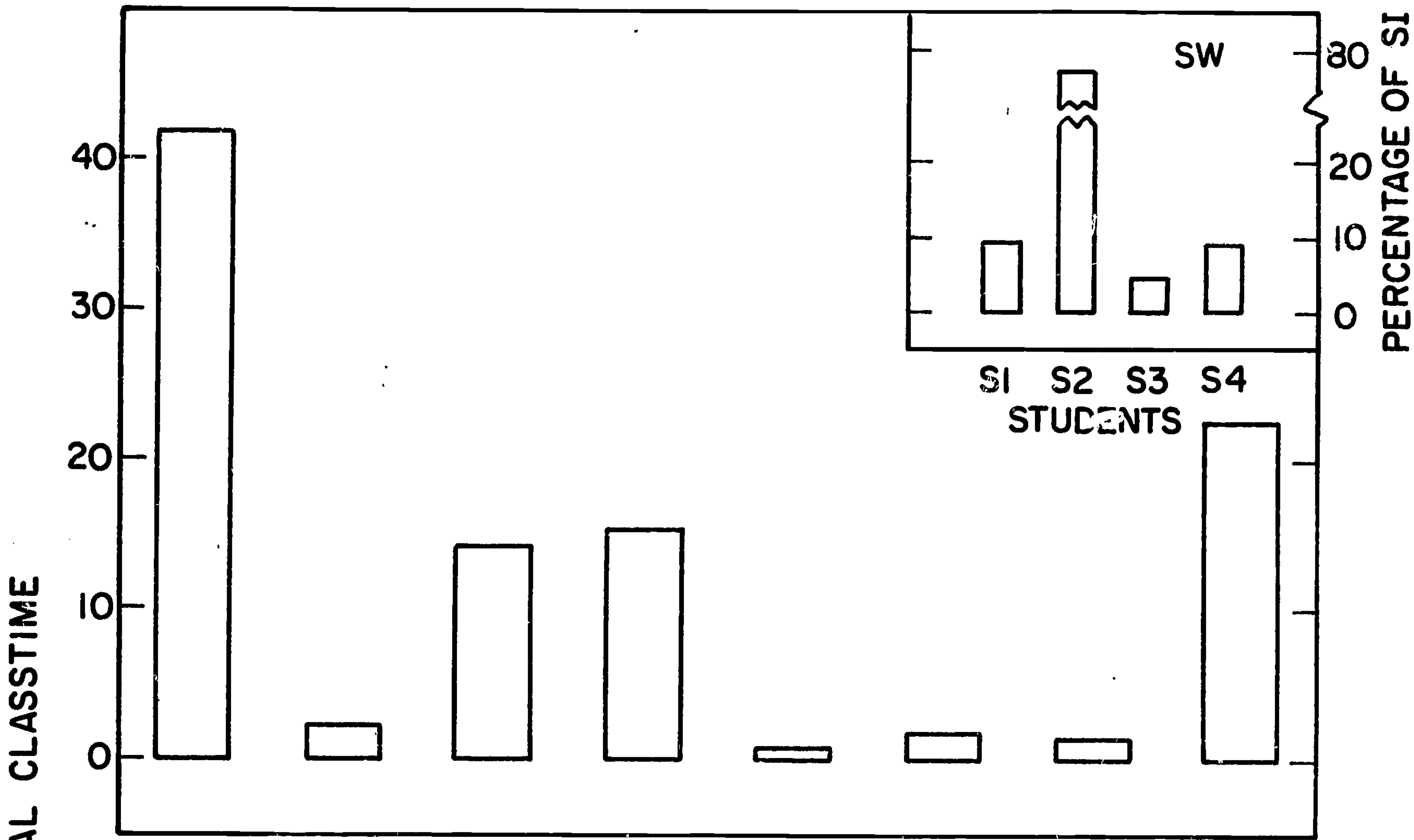

Fig. 5

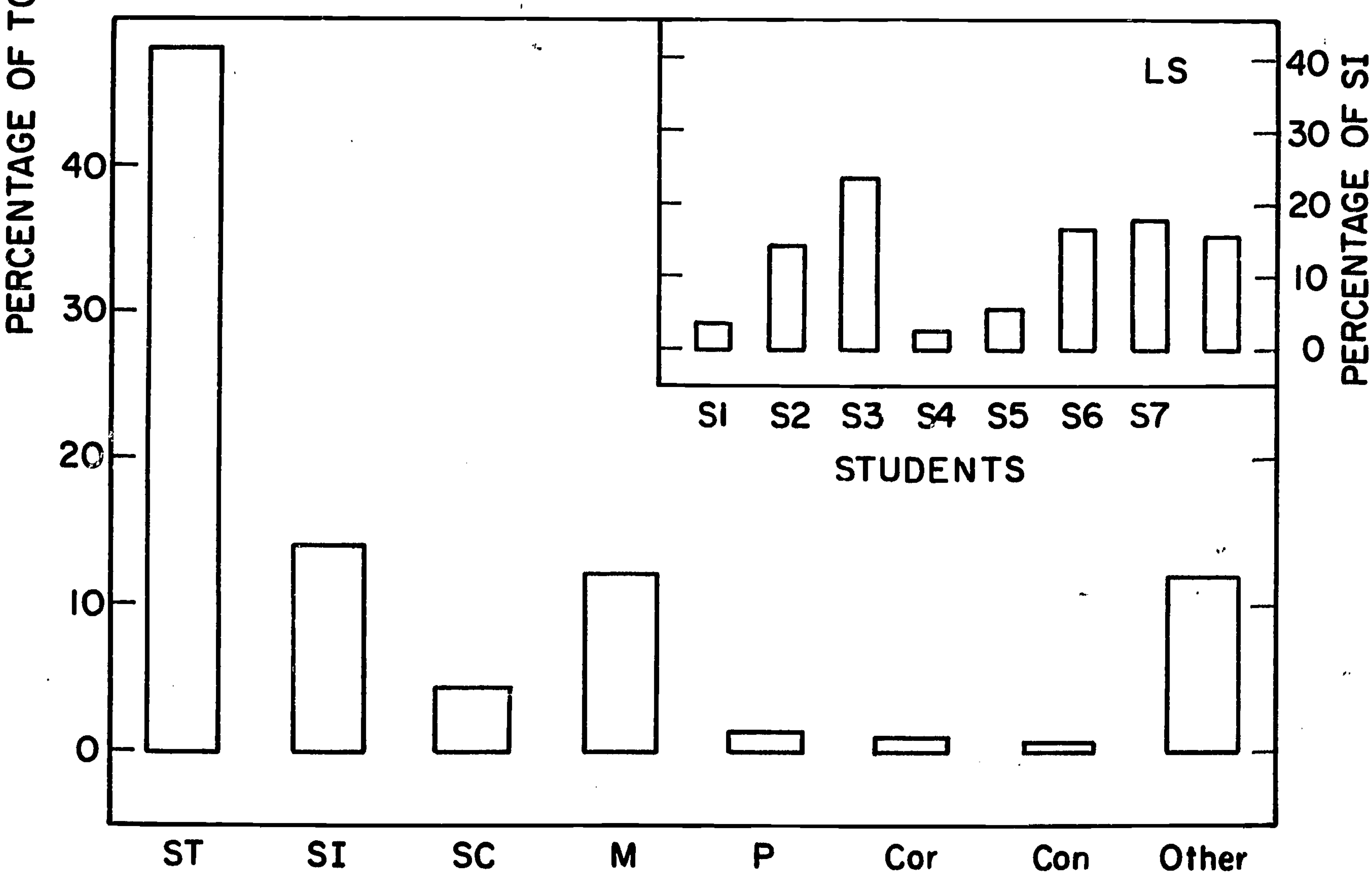

Fig. 6 TYPES OF CLASSROOM BEHAVIOR

Matching-to-Sample Bibliography

Addenda*

George L. Geis & Susan Neilsen

Center for Research on Language and Language Behavior

Berryman, R., Cumming, W.W., Cohen, L. K., & Johnson, D. F. Acquisition and transfer of simultaneous oddity. Psychol. Rep., 1965, 17, 767-775.

An ST hue physically located between a matching CO and an alternative CO was presented to six pigeons. Red, blue, and green were used as stimuli. Acquisition of correct responses to the alternative CO began above chance and improved slowly. Yellow was substituted for blue in programming to test for transfer of oddity performance. These results are discussed in terms of both a "coding hypothesis" (Lawrence, 1963) and "stimulus rules".

Cohen, L. C. Some data on transfer of matching without differential reinforcement. Paper read at Eastern Psychol. Ass., Atlantic City, April 1965.

"Birds were trained to m/s with red, green, and blue stimulus on a VR3 schedule of reinforcement. Trials with yellow stimuli were included on the non-reinforced portion of the ratio. Results are considered in terms of standard specific behavior, and the stimulus rules governing matching."

Cumming, W. W., Berryman, R., & Cohen, L. R. Acquisition and transfer of zero-delay matching. Psychol. Rep., 1965, 17, 435-445.

An ST hue was presented, then removed upon presentation of 2 CO's. Six pigeons were used as Ss. Acquisition of pecking responses to the matching

*These items are additions to the original bibliography appearing in Progress Report No. I, October 1965. Ann Arbor: Center for Research on Language and Language Behavior, University of Michigan.

CO was more difficult for these Ss than for Ss learning simultaneous matching. Yellow was substituted for blue to observe transfer effects. Transfer results are discussed in terms of a "coding hypothesis".

Markova, A. Ya. (Matching from sample in lower monkeys.) Voprosy Psikhologii, 1964, 6, 127-140.

Three rhesus monkeys were used in m/s tests. Correct choice of CO depended on color, form, and size. Ss learned quickly. (127 presentations of ST during two experimental days for one S.) The response set that developed was difficult to overcome. Both stereotyped behavior and natural preference increased with task difficulty.

Moore, R., & Goldiamond, I. Errorless establishment of visual discrimination using fading procedures. J. exp. Anal. Behav., 1964, 7, 269-272.

Preschool children were presented with a triangle as a ST. Three (triangles) two rotated into different positions, were then presented. The discrimination was established by initially illuminating only the correct CO. Then, gradually, the illumination of the non-matching CO's was increased until the three stimuli were equally bright, transferring stimulus control to form with minimal error.

Scheckel, C. L. Self-adjustment of the interval in delayed matching: Limit of delay for the Rhesus monkey. J. comp. physiol. psychol., 1965, 59, 415-418.

Four rhesus monkeys worked on a m/s apparatus that adjusted delay intervals contingent upon S's responses. Correct matching increased delay, and incorrect matching or response failure led to decreased delay. The "average limit of delay" for the S's final four sessions was 45.4 sec. with a range of 35.8-58.3 sec. The possible range was 1-105 sec. with delay intervals of 1, 3, 7.5, 15, 30, 90, and 105 seconds. Long training and the lack of spatial cues were noted as possible reasons for the stability of the results.

Sloan, H. N., Jr., & Harper L. J. Experimental control during an earthquake. J. exp. Anal. Behav., 8, 1965, 425-426.

A male retardate worked steadily at high accuracy on a modified Harvard m/s apparatus through a 30-45 sec. earthquake which registered 7 on the Richter scale.

GROUP D: LANGUAGE STRUCTURES

Research by members in Group D has centered on the analysis and formal description of language structures, especially--in recent months--on complex phonological structures and on linguistic structures larger than the sentence. Dominant in this group are the approaches and methods of descriptive/generative linguists, though psychologists and others have been closely involved in testing theoretical claims and in suggesting possible applications of purely linguistic research to problems of language development and pedagogy. Three projects are reported here: 1) Tagmemic and matrix linguistics applied to selected African languages; 2) Child language, aphasia and general sound laws; 3) Psychological reality of the paragraph as a grammatical structure (see abstract in Sec. III).

Despite the distraction of two revolutions (in Ghana and Nigeria), the chairman of Group D, Dr. Kenneth L. Pike, successfully completed a series of workshops and conferences on a wide range of problems involving more than a dozen African languages of the Niger-Congo family. In his third interim report, Dr. Pike reports primarily on work in progress involving the languages of Nigeria. This work has concentrated on the solutions to four recurring kinds of problems: 1) tone problems, especially those of the "terraced" tone systems typical of this language family, and including the development of morphotonemic rules which explain the relationships of the tone systems to verb structures in several languages; 2) problems of describing and reconstructing a decayed concord system from present-day traces in several languages; 3) problems of discourse structure, including the description of paragraph structure and the development of rules for the use of direct and indirect discourse in quotations; and 4) problems of clause description, especially the construction of matrices showing the relationships of various clause types. As is typical of his work, Dr. Pike's report has already stimulated a number of derivative projects, including instrumental studies of the physical parameters of "terraced" tone systems and vowel harmony in several African languages.

The work of Professor Roman Jakobson in describing universal phonological structures has been of major importance for many years to both linguists and psychologists. Dr. Alan Keiler, a member of the CRLLB and an associate professor of linguistics at the University of Michigan, provides a condensation of a translation he has recently completed of a 1941 monograph by Prof. Jakobson entitled, Child language, aphasia, and general sound laws. In the monograph Jakobson shows how evidence from the order of the development of language sounds in children and the order of the dissolution of language sounds in aphasics reveals a sharp binary stratification of the phonological system. This stratification provides important insights into the process of historical language change.

None of the CRLLB projects reveals more promisingly the benefits of the collaboration of scholars with very diverse backgrounds than the project of Alton Becker, Frank Koen, and Richard Young on paragraph structure. As one member said, "Each of us thinks we are doing something different, and each of us thinks the results show something different, and the interesting thing is, each of us is probably right." Provided here is an interim report on recent experiments in paragraph recognition, the results of which are forthcoming. The work of this group is very closely related to some of the discourse studies Dr. Iike directed in Africa, and its importance in the development of more effective language pedagogy is becoming increasingly evident.

Tagmemic and Matrix Linguistics Applied to Selected African Languages: Third Interim Report[1]

Kenneth L. Pike

Center for Research on Language and Language Behavior

(1) January 1-15: Phasing out the Ghana Workshop.

For the first week in January, Kenneth L. Pike, the Project Director, reviewed with the members of the Summer Institute of Linguistics the progress to date at the Ghana Workshop, and reached final judgments as to nature and content of the contributions which could be expected from them, and the excerpts of data desired for use by Pike, both for the final report and for future research to result in articles stimulated by the Workshop. The general content of this material is represented in the second interim report (January 7, 1966). During the second week of January, while Pike was traveling to Nigeria, members of the Workshop in Ghana followed up on the work on these desired details. In addition, as indicated in the second interim report, Dr. and Mrs. John Callow were asked to continue research along some especially profitable lines of development beyond the first materials presented in the Workshop.

(2) January 8-18: Project Director traveled to Nigeria.

In accordance with the initial plan, Pike visited scholars at the University of Ibadan, the University of Zaria, and the Center of Islamic Studies in Nigeria (at Ibadan, Zaria, and Kano, respectively). Unsettled conditions in Southwest Nigeria made traveling hazardous. By the time Kano was reached, a military coup took place, changing the political aspect of the country, and halting all travel. By private plane, however, the Project Director was able to reach Jos, and after a few days to proceed on January 18 to the University of Nigeria at Nsukka where the Workshop had already officially begun a few days earlier. In addition to discussing linguistics with scholars at Ibadan (e.g. Mr. Ayo Bamgbose, Miss Elizabeth Dunstan, Dr. Kay Williamson, Dr. Carl Hoffman, Dr. Robert Armstrong) and others at Kaduna (e.g., members of the British Council on teaching English) and Zaria (Prof. Frank Kapelinski) and at the Institute for Islamic Studies in Kano, lectures were given at the University of Ibadan and the University of Zaria.

(3) January 15-April 3, 1966: Second-half of Phase II - Workshop in Nigeria. Linguists attendant at the Workshop, members of the Summer Institute of Linguistics, included Ian Gardner, Amelia Gardner, Paul Meier, Inge Meier, Katherine Barnwell, Patricia Revill, Klaus Spreda, Janice Spreda, Elaine Thomas, Richard Bergman, Nancy Bergman, Thomas Edmondson, Eileen Edmondson, and Dr. John Bendor-Samuel; from the Assemblies of God Mission, Irene Crane, and Ruby Peterson; from the Sudan Interior Mission, Jean Soutar. In addition, in attendance during part of the Workshop, but not officially part of the project, were various members of the Evangelical Lutheran Mission: Charles Brehmer, Mariloux Brehmer, Paul Bruns, Pamela Bruns, Herbert Stahlke, Walter Schmidt, and others for brief visits.

Again, as for the Ghana Workshop, specific projects were selected for each linguist in such a way as to get the broadest coverage of the most acute kinds of problems occurring throughout the region as a whole. In general, however, more attention was required on phonological materials (in Nigeria) than was necessary in Ghana, for two reasons: (a) the linguists had been working a shorter time here than in the Ghana area, and hence phonology loomed larger as a problem; and (b) more important, since syntax had been emphasized heavily in the Ghana Workshop, it was necessary for Pike to work intensively on certain kinds of problems which were specific to Africa, especially, in reference to tone, but which were not known to occur elsewhere in the world with the same degree of relevance. These phonological problems, therefore, had to be given such considerable attention in order to round out the overall coverage of the two workshops as a whole. Nevertheless, the selection of members for the Workshop also led to especially interesting results in the analysis of discourse structure (Bariba) and on sub-morphemic fusion of old concord prefixes (Abua and Etung), and intensive work was done on clause structures, so that comparison could be made with the clause work in Ghana.

Here, as in the second interim report for the Ghana Workshop, the material is organized by language families. All of these languages, like those studied in Ghana, belong to the larger Niger-Congo family. Reference numbers following the language names refer either to their listing by Joseph H. Greenberg in The Languages of Africa, IJAL, 1963, 29 (1), part II, 9-10, or to the section in Greenberg which was most probable relevant classification, in the judgment of Dr. John Bendor-Samuel.

(A) The Gur Group (I.A.3.)

The Bariba Language (I.A.3.f.): Jean Soutar, linguist.

Miss Soutar was forced into the study of discourse structure, in order to answer one question: When is it appropriate to use direct versus indirect discourse in a quotation? Sharp misunderstandings had been resulting in lectures, when the audience was uncertain as to who was saying what. The astonishing result of this research based on 100 pages of varied texts was that matrix structures showed priority of person relationships (in the quotation indicator one had to know who was talking to whom before one could tell whether a direct or indirect quotation should be used). Similarly, there was a kind of "staging" of the general situation, such that "on-stage," "off-stage" affected the results. Several other criteria intersected in matrix form to give the ultimate pattern.

(B) The Kwa Group (I.A.4.)

The Izi Language (I.A.4.g.): Paul Meier, linguist:

Mr. Meier concentrated on selected phases of a "terraced" or "downstep" tone system, one of Pike's priority interests, since this type of system was not included in his book Tone Languages in 1948, but has been called to the attention of the linguistic world by Welmers. Many special problems developed which involved relationships between phonemically contrasting but phonetically similar adjacent pitches, and special residual tonal effects (differing from morphophonemics) from loss of low tones. The routine descriptive material is well along. Meier worked with eleven noun classes, in fifty different frames, to reach an understanding of their basic form and their changes in different contexts. Rules for phonetic conditioning and phonemic form, and for morphophonemic interchange were studied and integrated with the characteristic downstep problem. Two further steps are contemplated. Pike may later attempt a theoretical paper in which the implications of this kind of a system may be brought to bear to modify classical phonemic theory. Secondly, Dr. Brend, the Research Associate, may attempt some laboratory analysis of the contrastive materials brought back on tapes.

The Izi Language: Inge Meier and John Bendor-Samuel, linguists.

(a) Miss Meier and Dr. Bendor-Samuel set up a chart of the basic verb forms found with different tone patterns in the various aspects. Initial work was done on auxiliary and extensor suffixes with these forms, but considerably more work has to be done to show permitted occurrences for mutual exclusiveness. The negative forms also need rechecking. (Dr. Bendor-Samuel, late in March, presented a paper on this subject to the West African Language Conference in Yaoundé, Cameroons.)

(b) Miss Meier, following the completion of the descriptive material with Bendor-Samuel on part of the verbal system, has begun to work on the structure of the clause.

The Igede Language (I.A.4.f?): Richard Bergman, linguist.

(a) Bergman showed tagmemic formulas of basic clauses, and some relation between them in matrices.

(b) Bergman also provided the Workshop with material from Igede showing four contrastive tone levels.

(c) A brief note on the verb morphology is included - the verb structure in this language is very simple.

The Igede Language: Nancy Bergman, linguist.

Miss Bergman, although not part of the official linguistic crew of the Workshop, provided us with data on noun phrases in Igede. She demonstrated that there are four degrees of fusion between nouns. From complete freedom of combination, successive degrees of coalescence lead to compounding in which one or more parts of the compound lose their distributional freedom and their semantic identifiability.

The Yachi Language (I.A.4.f?): Herbert Stahlke, linguist.

Stahlke was one of several members of the Evangelical Lutheran Mission who, during the Workshop - but not as an official part of the project - were given suggestions for learning some of these African languages. Specifically, this gave an opportunity to have these individuals answer questions such as, "What do you not know yet?", "What have you learned in relation to the total structure?", "What kind of linguistic bookkeeping system can be arranged to let you see both the degree of progress that you have achieved and the goals where research is probably needed to gather further material?" Stahlke, while using matrix techniques to try to answer these questions, kept some record of his progress and outlook which may be made available to the report. If so, it will be a direct point of contact for showing how matrix handling of clause structures can aid in the planning and development of textbooks.

The Degema and Engenni Languages (I.A.4.e. Ed. branch -related to Greenberg's Bini): Elaine Thomas, linguist.

Miss Thomas investigated certain tone characteristics of Degema, with some relation to a related language, Engenni. The system has a "downstep" characteristic, like that reported for a number of West African languages, but with certain special restrictions: the downstep has extreme limitation in placement,

(a) with occurrence limited to a position before juncture, but after high tone. The Degema downstep is cognate with certain low tones of the closely-related Engenni language. A second interesting feature - also found in some other West African languages - is an extra high tone which signals the negative of the verb, but is placed on the personal prefix - or upon the subject nominal phrase preceding the verb, when no prefix occurs. In Degema the verb has an obligatory personal prefix except in the imperative singular; and extra high tone signals the negative on the personal prefix. In Engenni, however, the verb has no personal prefix, and the extra high tone has been transferred to the final syllable of the preceding noun phrase.

(b) Brief notes were also made available, giving initial view of some clause nuclei for a syntax paradigm, as well as initial notes showing the orders of affixes in a verb chart. This latter material, however, was incidental to the main thrust mentioned, and will be used only if needed to round out a more extensive view of the clauses of the region as a whole.

(C) <u>The Benue-Congo Group (I.A.5.)</u>

<u>The Abua Language</u> (I.A.5.): <u>Ian and Amelia Gardner, linguists</u>.

The Gardners collaborated on several problems in Abua.

(a) They worked on a problem of verb morphology. There, prefixes show very old layers of fusion between tense (or aspect), person, number, and human versus non-human categories. The patterning of the prefixes can be seen through various kinds of matrix perturbation, with irregularities in some areas, but with ranking characteristics in others. Superimposed upon this, however, is an extremely interesting fusion of an old concord item reflecting an object prefix. A matrix, in which a front high vowel outranks others, in special patterns, and then fuses with the former matrix just mentioned, shows an inter-section of matrices which clarifies an enormously complex fusion process. This material may prove to be of special theoretical importance, with historical overtones, in showing how the elaborate concord systems of the Bantu of southern and eastern Africa can be related to decayed concord systems further west.

(b) The tone structure has a downstep feature, with two contrastive tones. In addition, however, there is a special high tone, restricted to certain negative situations, where the extra tone level has an interesting overlay of intense or harsh voice quality. Tape recordings of this material have been made available to us, and we hope that Dr. Brend will be able to analyze something of the acoustics of this phenomenon. There may be an intersection of voice quality with tone - creating the "extra high tone" which would be of theoretical interest.

(c) Also made available are tape recordings of extensive lists of words with vowel harmony. Here, again, Dr. Brend may be able to integrate the study of voice quality in one of these Nigerian languages with the results growing out of the study of Twi from Ghana.

In addition:

(d) Certain dynamic characteristics of rhythm units, where there is some relationship between timing of stress groups with a variant number of syllables may also be used to support material on the Basare work of Ghana, showing that this rhythmic characteristic is widespread in West African languages.

<u>The Mbembe Language</u> (I.A.5.B. - related to Jukun, and to Winston's "Cross-River Group" but not Greenberg's "Cross-River Group": <u>Katherine Barnwell, linguist</u>.

(a) Miss Barnwell undertook for our Nigerian Workshop an extensive handling of clauses within a sentence. In order to do this, she first treated simple clauses in terms of contrast, variation, and distribution, and in terms of a two-dimensional matrix of construction-times-component. After illustrating these with a syntactic paradigm she then attempted to show variants of clause types as they occurred in larger units of the grammatical hierarchy. This led to the study of close-knit clause composites ("serial clause constructions") and to preliminary suggestions as to the relation between such clause sequences and the structure of the sentence. This paper, therefore, gives the closest integration with the papers on clause and sentence sequence growing out of the Ghana Workshop.

(b) Some preliminary work, both below the clause and above the sentence, is underway. Barnwell is continuing on an analysis of the phrase, and is also searching for clues concerning the paragraph structure.

I. <u>Mbembe Language: Patricia Revill, linguist.</u>

(a) Miss Revill concentrated on certain characteristics of the phonological structure. Specifically, this was the one language in which we attempted to find some relationship between phonological characteristics and gestural ones. In somewhat impressionistic form, voice quality characteristics and pitch contours were recorded. Simultaneously, notation was made from gestures given by the informant. Certain phonological "expressive" features were ambiguous by themselves - but when these structures were conflated with the matrix of gestural types, the ambiguity was cut.

(b) In addition, she did some preliminary work on rhythm-group division, as a prelude to studying the basic system of accent in the language.

The Agbo Language (I.A.5.B?): Klaus and Janet Spreda, and John Bendor-Samuel, linguists.

The Spredas, in consultation with Bendor-Samuel, prepared a routine phonemic analysis of the Agbo language. This language has been but little studied, and there was not opportunity or time to push the analysis into the higher grammatical levels. On the other hand, this was one of the few places in the Workshop where specific attention was put on a phonemic system as such, since elsewhere attention was focused on more exotic problems. We were glad, therefore, to have this particular statement to round out our approach to the problems in the area as a whole.

The Bette Language (cf. I.A.5.C.1 - a language related to Yakoro, which in turn is normally called Bekearra, one of Greenberg's "cross-river" languages): Irene Crane and Ruby Peterson, linguists.

(a) Miss Crane and Miss Peterson showed that there were three contrastive levels of pitch normally and clearly present. Nevertheless, a kind of downstepping occurred on sequences of high pitches (but not in the same way on sequences of mid pitches or sequences of low pitches). In spite of the downstepping highs, contrasts continued with mid or low tones inserted in the sequence. Rather than finding the source of the downstep in the loss of a low tone (more frequent in the area), the relevant downstep seemed to be developing as some kind of fusion of dynamic groups in this downward drift of the upper level.

(b) Various problems in the analysis of the phonemes took some attention - consonant clusters, complex consonant phonemes, the assignment of centralized vowels to various appropriate phonemes.

(c) Considerable work has been done on the morphophonemic replacement of tones in various grammatical constructions, with preliminary rules for these changes.

The Boki Language (I.A.5.C.1): Charles Brehmer, Paul and Pamela Bruns, linguists.

Note comment earlier, about these non-official members of the Workshop. Boki is one of the languages which served as an experimental base for trying out some of the pedagogical implications of matrix theory. (See discussion above, under the Yachi language.)

(D) The Bantoid Semi-Bantu Sub-Group.

The Etung Language (I.A.5.D?-Bantoid? - No clear analysis of the language family affiliation is available yet, although the general Ekoid group is being studied extensively by Professor Crabb of Princeton, with data not available to us): Thomas Edmondson, linguist.

(a) Edmondson studied the relationship between segmental and tonal structures of verbs in Etung. There is a widespread characteristic of West African tone languages, within which two verb classes appear with widely different morphotonemic rules. The tone patterns of the verb stems and their extended cores are shown in a matrix including person, number, and basic tone characteristics as one dimension, intersecting with tenses and the two principal tone classes as the other dimension The patterns are extensively illustrated, with a citation paradigm.

(b) Pike has been considering a theoretical paper which might suggest how some of these morphophonemic changes enter into a chain reaction. If the initial understanding of some of the underlying processes can be guessed at, it is hoped that later on Edmondson may be able to test some of the hypothesis in a more extensive way. If this, in turn, holds up, it should have implications for a broad range of languages which have similar characteristics recurring over a wide geographic area.

The Etung Language: Eileen Edmondson, linguist.

Mrs. Edmondson, in working on the concord system of this Bantoid (or "Semi-Bantu") language, discovered a strange constraint on the permitted pairings of the singular-plural prefixes The study of these restrictions, through matrices and ranking relations, allows a descriptive statement of considerable elegance, and of a type not previously known to us. This constraint involves front and back vowels; it intersects elsewhere in the concord system, with other constraints of high and low vowel characteristics, rounded and unrounded, and front and back characteristics. This should have some interest for the historian of Bantu - inasmuch as some of these kinds of characteristics show up in the matrix permutation material reported by graduate assistants on the project who investigated some of the published literature on Bantu languages.

(4) Lectures to the University of Nigeria (Nsukka Campus), January-April, 1966: While the Workshop was in session (in the building of the Continuing Education Center), Pike gave a series of weekly seminars to students of the Linguistic Department of the University. (These were not an official part of the Project, hence this part of the Project Director's

time was not on the project budget.) In addition, at the beginning of the Workshop, a monolingual demonstration was given, to show the university community the techniques involved. At the end of the Workshop, with the Vice Chancellor chairing the meeting, and the Chairman of the University Council and other officials in attendance, members of the Workshop gave brief reports of the linguistic discoveries which they had made. This collaboration was designed to strengthen the work of linguistic analysis in the country.

(5) West African Language Congress, Yaoundé, Cameroun, March 17-23, 1966: Dr. Pike and Dr. Bendor-Samuel (Director of the work of the Summer Institute of Linguistics in West Africa), attended the Congress sponsored by the West African Linguistic Society. (The place and date were not announced until after the Project Director was in Africa. He had assumed, in the project proposal, that it would be in Dakar, and would therefore be a stop on the return trip to the U.S., but the arrangements were changed later.) Bendor-Samuel presented a paper on the Izi Verb Structure, while Pike summarized several of the tone problems studied, as well as the problem of direct and indirect discourse in Bariba, under the titles "Comments on African Languages, Part I: Phonological Hierarchy of Tone; Part II: Some Rank-Structured Components of Discourse."

At this Congress we were able to meet various scholars interested in African languages, and discuss with them some of the problems of interest. These included, amongst others, J. M. Calvet, Faculty of Letters, University of Dakar, Senegal; Miss L. Criper and Dr. F. Dolphyne, Department of Linguistics, University of Ghana, Legon, Ghana; Miss E. Dunstan, University of Ibadan, Nigeria; Dr. C. Hoffman, University of Ibadan;

Dr. A. Bambgose, University of Ibadan; Professor P. F. Lacroix, École National des Langues Orientales, Paris, France; Professor G. Manessy, Faculté des Lettres, Aix-en-Provence, France; Dr. S. Sauvageot, Faculte des Lettres, Dakar, Senegal; Dr. Kay Williamson, University of Ibadan.

(6) Summary:

The Second-Half of Phase II (that is, the Nigeria Workshop) is finished as far as the Project Director's immediate presence in Nigeria is concerned He has asked several members, however, to do some further work carrying on the lines of research which he has suggested. (These come within the funds originally budgeted for the African Workshop, and under the provision in the proposal that further linguists could be added, within that budget, as needed.) Our needs here were rather for more extended work by these scholars, rather than for the addition of extra scholars. The specific linguists included are: Katherine Barnwell, Patricia Revill and Ian Gardner, half-time for two additional months; Paul and Inge Meier, two weeks; and continuing, in Ghana, work by John and Kathleen Callow for that part of their time which is made available, by the Summer Institute of Linguistics, up to the first of June, 1966 The kind of work in which they will be engaged is described in the present report, with the exception of that of the Callows, which is described in the second interim report.

Problems in the second Workshop ranged from phonemic analysis through the study of literary genres. Concentration was (a) on tone problems, (b) on matrix handling of broken-down concord systems, (c) on matrix handling of indirect and direct discourse, (d) tagmemic and matrix approach to clause studies.

Phase III is now under way. The Project Director is beginning to assess the material collected to see how it can best be utilized for the final report.

Dr. Brend, as Research Associate (a) will be deeply involved in getting the report ready. In addition, (b) she will be studying tape recordings of several of these languages, to see which of them might lend themselves to laboratory study at the University of Michigan, and supplementary collaborative publication. She has begun work in this direction, on the Twi, Basare, and Agbo languages.

Charles Peck, Graduate Assistant at the University of Michigan, has been helping to prepare some of the spectrographic and other laboratory material for analysis by the Project Director and Research Associate.

Pike and Miss Brend will be working on the report at the University of Michigan through May. From June through August, they will be working part-time on the report at the University of Oklahoma, returning in late August to the University of Michigan.

Footnote

1. This article is reproduced from Dr. Pike's narrative account of Phase II of the project on African Languages, submitted to the U.S. Office of Education on April 29, 1966.

Child Language, Aphasia, and General Sound Laws

Allan R. Keiler

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Jakobson's 1941 monograph, Child language, aphasia and general sound laws, is the only systematic attempt to interrelate the phonological development of children and the phonological dissolution of aphasics with the general phonemic patterning that underlies language typology and language evolution. Consequently, the monograph is of considerable interest and importance not only to linguists, but to speech pathologists and psychologists as well. The translation of the monograph into English by the present writer (A.R.K.) may be valuable, therefore, to scholars in these areas. The following section headings from the translation and a brief précis indicate the contents of the monograph.

I. The Phonological Development of Child Language and Aphasia as a Linguistic Problem

1. Types of linguistic activity. - 2. Interaction between child language and the languages of the world. - 3. Occasional and constant agreements. - 4. Recording and analysis of the beginnings of child language. - 5. Principle of least effort and cessation of babbling sounds. - 6. Emergence of the speech sound. - 7. Interjectional sounds. - 8. Supposed exceptions to order of phonological development. - 9. Dissolution of the phonological system. - 10. Sound and meaning disturbance. - 11. Linguistic character of aphasic sound-deafness and sound-muteness.

II. Stratification of the Phonological System

12. Relative and absolute chronology of phonological development. - 13. Minimal consonantismus and minimal vocalismus. - 14. Identical laws of solidarity in

the phonological development of child language and in the synchrony of the languages of the world. - 15. Late or rare phonological acquisitions. - 16. Relative intensity of phonological utilization. - 17. Panchrony of the laws of solidarity. - 18. Laws of solidarity and speech pathology. - 19. Normal speech disturbances. - 20. Uniformity of stratification.

III. Foundation of the Structural Laws

21. Atomistic attempts at explanation. - 22. Structural trend of development. - 23. Split consonant-vowel. - 24. Opposition nasal-oral in consonants and vowels. - 25. Splitting of consonants into labials and dentals and vowels into wide and narrow. - 26. Splitting of consonants into front and back. - 27. Agreements between the systems of sound to color. - 28. Classification and the structure of higher units. - 29. Place of the dentals in the consonant system. - 30. Secondary gradations of phonological contrasts.

IV. Concluding Observations

31. Prospects. - 32. Glottogony. - 33. Principle of language change.

Part I points out similar trends of phonological development in child language and in the phonological evolution of language and refutes explanations for the observed generalities based on purely visual or physiological grounds. Speech disturbances are then distinguished according to whether linguistic competence (i.e., the "sign-functioning ability") is impaired, or whether merely the physiological or neurological basis of speech is affected. Only the former disturbances are termed aphasias by the author. The phonological facts observed in the aphasic's linguistic regression are compared with the facts of phonological acquisition.

Part II discusses the actual phonological universals recorded in language acquisition, and those found in aphasics are shown to be the mirror image of the former. Thus the same stratification of distinctive features underlies both child language and aphasia. Part III is an attempt to provide an explanatory basis for the underlying universals of phonological stratification. The primary sound parameters of chromatism-achromatism and width-narrowness are discussed with relation to speech sounds, and the binary nature of phonological stratification is stressed.

II. Research in Progress Abstracts

Group A Language Processes

Rhythm of Spoken American English (George Allen)

Data on the reliability and validity of two measures of "syllable beat" are presently being analyzed. In the first experiment each S tapped his finger in time to the rhythm of the syllables of various rhythmic utterances chosen from normal conversation. The temporal placement and the variability of the tap were used, respectively, to measure the location of the syllable beat and the role of the syllable in the overall rhythm of the utterance. In a second experiment each S placed a movable click so that he felt it occurred "when he would have tapped" had he been tapping his finger as in the first experiment. Again the location and variability of click-placement were used to make the same measures as those in the first experiment. In a final experiment each S tapped his finger in rhythm to a series of pre-recorded clicks. The object of this third experiment was to obtain a rough calibration of the displacement in time of a given S's taps from the "actual" time of the beat and his reliability in repeated experiments.

The following conclusions have been drawn from the data:

(1) Different Ss do not tap at the same place in a given syllable.

(2) Different Ss do not place the click at the same place in a given syllable.

(3) S does not place the click where he taps.

(4) There is some shifting in time of the place where S taps; this shifting is presumed to be the principal source of intra-S variability in repeated experiments.

(5) Ss differ in their "absolute" variability in tapping, but their relative variability in tapping from one syllable to another is positively correlated and related to the rhythmicalness of the syllable.

(6) Variance in click placement does not seem to differ between Ss, nor is it related to the rhythmic role of the syllable.

(7) The "actual" location of the syllable beat, as measured by these two behavioral tasks, appear to be in the initial consonant sequence of the syllable, a finding in rough agreement with previous studies of the syllable beat.

An Experimental Analysis of Self-Descriptive Verbal Behavior (Daryl Bem & Carl Cohen)

This research centers its concern on the variables controlling stable, long-range self-descriptions, including the kinds of verbal statements an individual makes when filling out a standard personality inventory. If these self-descriptions can be manipulated, a step will have been taken beyond the simple proof of the existence of the self-perception phenomenon (see article by Bem in present Report) to a consideration of self-descriptive behavior of importance in clinical work and in natural social environments. Important methodological implications can also be considered, because experiments in personality and social psychology so often employ verbal self-descriptions as their dependent variables. An experiment now being carried out attempts to bring verbal self-descriptions on a set of personality scales under discriminative stimulus control so that an individual will display either of two "personalities" depending upon the presence or absence of an arbitrarily selected visual stimulus.

Another set of studies aimed at the same basic questions, but employing a quite different methodology, is planned. These studies will utilize the "T-group" as a research instrument. A "T-group" is, among other things, designed to enhance an individual's perception of both himself and others. There is now sufficient research experience with the T-group, and enough evidence for its efficacy in changing an individual's self-perception, to warrant some optimism about providing answers to the questions raised about the ontogeny of self-descriptive skills.

In testing and developing the interpersonal model of self-perception and description, the conclusion has repeatedly been reached that a popularly held position is wrong; viz., that reinforcing a person for saying something contrary to his beliefs and attitudes is the crucial variable in producing attitude change through self-persuasion. It now seems that the popular belief may be valid if refined; that is, if the reinforcing effects of the feedback given Ss can be separated from its discriminative (informational) function. It is predicted that the discriminative functions of the feedback will prove to be the crucial variable, providing S with a self-observation that leads him to modify his belief and attitude statements.

Mechanical Speech Recognition (J. F. Hemdal & D. Vander Yacht)

The computer-based model of phoneme recognition being developed will employ the perceptual referents of acoustic parameters. We desire, ultimately, to simulate closely the type of decision processes employed by the human listener in receiving meaningful speech and in setting down a written equivalent of what he hears. This will require a determination of the relative contributions of linguistic and articulatory constraints and of meaning to speech communication.

The present capability of mechanical speech recognizers (Dammann, 1965; Hughes & Hemdal, 1965; Zadell et al., 1964) may be described as achieving:

1) The recognition of stressed vowels embedded in carefully-pronounced monosyllables with an accuracy comparable to human perception when the device is adjusted for the particular speaker.

2) The recognition of consonants with an accuracy of 60 per cent to 75 per cent which falls far short of the recognition by human listeners.

Any extension of the highly-controlled input stimuli in the direction of natural, continuous speech results in a very considerable degradation of recognition.

This decrease in accuracy (compared with human recognition) results from (a) the inability of computer recognition schemes to provide for shifts in the vowel parameter space from one speaker to the next, (b) the centralizing tendency of both stressed and unstressed vowels in going from isolated words to continuous speech, and (c) the inability to correct perceptual errors by utilizing linguistic and articulatory constraints. Long-range plans call for an investigation into each of these limitations on computer recognition. The initial effort is a study of the possible automatic techniques for normalization of vowel-spaces that may be useful for overcoming difficulties with inter-speaker variability.

The realization of the importance of a short-time spectral representation of the speech signal (Flanagan, 1965) implies that decisions leading to recognition be based upon physical parameters derived from a frequency analysis. A bank-of-filters type of spectral processor, providing an estimate of the envelope of the frequency spectrum, was used to compute the bulk of the spectra and "back-up." Calculations of the exact short-time Fourier spectra are used as a check for accuracy and a control on processing.

The data used in the normalization investigation consist of lists of 230 hə'CVC words providing 10 cardinal vowels in all possible contextual [CV and VC] environments as carefully spoken by six male and two female speakers. At present, the vowel space (formant one vs. formant two, determined by a peak-picking scheme) has been plotted for three male speakers and the remainder of the set is being processed. It is too early to discover a possible effective normalization technique from this small set of data; lowering the large variation of formant locations from one speaker to the next and the relatively small variation within a single speaker give encouraging indications that proper formant frequency normalization will greatly enhance the recognition results. An attempt will be made to relate an individual's vowel space with a standard test utterance that will adequately provide the *a priori* information needed for the normalization.

Although a direct relation exists between articulation and acoustic waveform, it is believed that this direct relation will not extend to an individual's parameters of vowel production because of the possibility of cultural influences. It is probable that a talker compensates, in part, for differences in vocal tract dimensions by a change in articulation. Yet inter-speaker vowel space differences seem to preclude the possibility of a complete compensation and at the same time, successful perception seems to rule out complete independence among formant locations for the cardinal vowels.

A tentative hypothesis is proposed that an individual speaker's vowel parameter space may be described in terms of just four vowels--/i/, /æ/, /u/, and /ɔ/--which represent the extreme positions of the formant locations possible for that speaker. The four lax vowels of English, then, would be described by means of these four tense vowels and a universal neutralizing or centralizing tendency. The remaining two tense vowels will be assumed to take on formant values between /I/ and /ʊ/ for the case of /ɤ/, and /æ/ and /ɔ/ for the /a/. This hypothesis will be substantiated by quantifying a possible neutralization tendency and by showing that such a measure will provide vowel recognition comparable to listener perception.

Relation of Physiological Arousal and Personal Opinion with Accuracy of Both Logical Inference and Recall Involving Connected Verbal Discourse (Frank Koen, Jon Williams, Steven Fisher)

The study investigates the question whether previous findings relating physiological arousal, as measured by Galvanic Skin Response (GSR), and the recall of individual items in pair-associated learning can be extended to verbal elements in connected discourse (logical syllogisms). The experiment also explores (a) the relation between S's agreement or disagreement with message content, and the recall of the message, and (b) the relation betweeen both GSR and personal opinion on the one hand, and accuracy of logical inference on the other. The experimental stimuli were 12 syllogisms, three of each of four logical forms, equated in difficulty, length in words, and position of item to be recalled, but varied (via pre-test) in judged degree of emotionality. Both GSR records and expressions of personal agreement/disagreement were obtained from Ss in Group 1 to each sentence of each syllogism, followed by judgments of the validity of the argument. In Groups 2-5, the main effects of instructions to remember the material, and of the interval between presentation and recall (15 minutes vs. one week) were studied, with the independent variables again being GSR and personal agreement. In the recall condition, the Ss were required to supply the one word missing from the first sentence of each syllogism. All data have been collected, and tabulation and analysis has begun.

Color Labelling, Color Discrimination, and Color Discriminability in Two Language Groups (James Kopp)

Subjects from two language groups are being compared for discriminability of hues, discrimination of hues, and the naming of hues.

The naming of hues is assessed by instructing S to assign labels to monochromatic spectral stimuli presented singly through a tachistoscopic shutter. The labels used are restricted to those generally taken to be minimal for complete labelling of the visual spectrum.

Next, the discrimination of hues is assessed by presenting adjacent stimuli for comparison and by having S indicate whether they are the same or different.

Both before and after the naming and discrimination phase, data on the relative discriminability of hues are to be obtained by sweeping the visible spectrum, thus changing wavelength continuously, while S presses a key to indicate each discriminable change in hue.

Initial results for English-speaking Ss show that the three kinds of data are interrelated; where a change in color name divides the spectrum, both discriminability (number of responses to change) and discrimination (per cent correct judgments) are better. This result accords with what is known about categorical perception on other continua, significantly, speech continua (Lane, 1965).

Contrastive Analysis of the Phonology of American English and Modern Literary Arabic (E. McCarus & R. Rammuny)

This contrastive study will treat the phonologies of American English (AE) and modern literary Arabic (MLA) from a pedagogical viewpoint. The major aspects of the research are: (1) to determine the specific areas of difficulty encountered by American students of Arabic, which will provide the foundation for the preparation of programmed teaching materials, leading to fluency and correctness in the phonology of MLA; and (2) to study the structure of the Arabic writing system, both as a discrete system in itself and as it relates to the phonological structure. Also to be derived from this study will be a set of penmanship exercises to develop an acceptable hand in Arabic.

Functions of Speaker and Listener Vowel-Spaces in the Imitation and Identification of Spoken Vowels (S. Ross)

Four sets of 10 spoken (sustained) vowels have been collected from each of five American speakers. These vowels are now being analyzed on the Sonograph. The measurements of pitch, and of frequency and amplitude of the first three formants, for one set of 10 vowels have been employed to generate synthetic vowels with these characteristics on the PDP-4 computer. Subsequent analysis on the Sonograph yielded excellent agreement with the specified parameters in most cases; the remaining cases serve to formulate strategies for reading off the Sonograph sections. An auditory comparison of spoken and synthesized vowels remains to be performed.

Psychological and Associative Meaning in Auditory Recognition (R. D. Tarte, H. Gadlin, & D. Spenser)

Ehrlich, Gadlin, and Tarte (1964) found that, in an auditory recognition task, Galvanic Skin Response (a measure of arousal) and associative meaning are correlated. The present study is an attempt to replicate these results with better controls; it also includes an attempt to examine the critical variables involved.

One hundred eighty female college students served as Ss. They were run individually. The procedure was as follows: each S heard 10 accelerated words followed by an interval of .16, 1.6, or 16 sec., and then a single word at normal speed. The task was to indicate whether or not the test word had been in the list of accelerated words, and how sure the S was. The test word was related to one of the 10 accelerated words in one of the following four ways: 1) Correct (C)--actually a word from the list; 2) Semantic (S)--high relatedness to one of the 10 accelerated words; 3) Phonetic (P)--rhyming with one of the accelerated words; 4) Wrong (W)--not related in any ascertainable manner. Each S received 24 separate trials. There were 5 different conditions for the accelerated items: normal (1 word per sec.), double (2 words per sec.), double-compressed (2 words per sec., no change in pitch), mid (1 1/2 words per sec.), and mid-compressed (1 1/2 words per sec., no change in pitch). These five conditions combined with the three delay intervals make 15 groups of 12 Ss each.

GSR was recorded throughout the session and deflections were measured from the onset of each test word for 12 seconds.

All data have been collected, and will be analyzed as soon as a computer program is completed.

The Perception of Grammaticalness by Adult Aphasics (Ronald Tikofsky, Rita Tikofsky, Merilee Oakes, & Ray McInish)

Two orders of 50 pairs of statements have been recorded. The computer program and response equipment have been prepared. In addition, material and forms for having normal Ss scale the statements have been completed.

A preliminary pilot experiment was carried out using 11 normal Ss. The Ss were required to select which member of the pair presented through a loud-speaker they believed to represent the better approximation to an acceptable English sentence. They indicated their preference by pushing one of two buttons on a panel. The computer recorded both preference and latency.

Seven of the Ss received order 1 on day 1, and 4 different Ss received order 2 on day 1. Only 5 of the 11 Ss were able to return for a second experimental session. Two of this group received order 2 on day 2, and the remaining Ss received order 1 on day 2.

All Ss were asked to scale the 100 statements on a seven-point scale of grammaticalness after obtaining preference responses.

Data obtained from this pilot study are now being analyzed. It is expected that the results will be indicative of trends to be expected when large numbers of Ss are run. However, there appear to be differences among pairs of sentences, with respect to the influence of morphemic structure on preference. Response latency appears to be a valuable measure in this research.

As soon as arrangements have been completed and cable installed, we will have an on-line arrangement with the computer at CRLLB, and will run aphasics at the Speech Clinic. Thus far, data have been collected on 30 normals at CRLLB. We expect to collect data on 25 aphasics during July and August, and to continue the experiment into the fall, using new Ss while analyzing the data obtained this summer.

A related study, for which the preparation of stimulus materials is in progress, concerns syntactic generalization by aphasic adults. A matching-to-sample task will be employed to establish baseline measures of the generalization of syntactically structured stimuli. From these findings various sets of stimuli will be prepared for use in learning experiments.

The Patterns of Airflow during Pronunciation: A feasibility Study for Automatic Recognition and Evaluation of Speech (J. C. Catford, H. Lane, Ruth Oster, T. Rand, & F. O'Donnell)

The construction of a matrix of 64 hot wire anemometers (4 3/8" x 4 3/8") is nearing completion. Through the use of a multiplexor and A-D converter, a digital measure of the velocity of the air passing by each anemometer during articulation will be stored in the computer. The whole matrix is sampled approximately 120 times per second. Since there is storage available for approximately 112 matrices, at any given time, approximately 1 second of air flow is stored.

The program for this conversion can also do the following: 1) display the matrix on an oscilliscope in real time with intensity as a measure of velocity; 2) freeze the current matrix on an oscilliscope; 3) print out all matrices in storage; 4) sum the air flow for each matrix and print these sums; 5) calculate and print an average matrix for occurences of isolated sounds by finding the matrix with maximum air flow and averaging it with the two preceding and following matrices.

Programs are currently being written for converting these average matrices of isolated sounds into binary matrices through the use of a flow threshold (cut off value). All the average binary matrices for a given sound will then be averaged to produce a characteristic binary matrix for each sound. Various methods of pattern matching will then be used to match matrices of unknown sounds with those of known sounds. The basic pattern-matching procedure will probably be a 1-1 comparison of elements of the matrices.

Group B Language Acquisition

The Changes in Language Functioning of Pre-School "Deprived" Children as a result of a Language-Oriented Pre-School Curriculum (L. Barritt & M. Semmel)

It is the purpose of this study to determine whether measurable changes in the psycholinguistic ability of deprived children can be produced by the introduction of a language-oriented pre-school curriculum. Forty-five "culturally deprived" pre-school children in Ann Arbor and Inkster, Michigan, will be tested in the Fall at the beginning of the pre-school program. During the year the investigators, working in cooperation with the pre-school teachers, will develop techniques for improving the language habits of these children. In the Spring these children will again be tested to determine whether measurable changes have been produced. A control group of 30 children in Inkster, Michigan, will be pre- and post-tested without the introduction of the special language program during their pre-school experience. The Illinois Test of Psycholinguistic Ability as well as supplementary measures developed by the investigators in previous research will be used to assess changes in the pre-school children.

A Comparison of the Changes in Psycholinguistic Functioning of Educationally Deprived Children After One Year in an Integrated School (L. Barritt, M. Semmel, & P. Weener)

This study is part of a project begun one year ago. It was our purpose to examine the changes in language functioning of a group of children who had attended a segregated school and were now to be bussed to an integrated public school setting. The pre- and post-testing of these children is completed and at present the data from the posttesting are being analyzed. An analysis of the pretest data has already been published under the title "The comparison of the psycholinguistic functioning of educationally-advantaged and educationally-deprived children."

An Analysis of the Prosodic Features of Deaf Vocalizations (L. Barritt, M. Semmel, H. Lane, & D. Spenser)

This is a pilot project to examine the prosodic features of the vocalizations of deaf children. The speech of approximately 40 deaf children will be recorded and analyzed using the SAID system. A description of the system is available in earlier publications of the Center for Research on Language and Language Behavior. It is hoped that after a description of the prosodic features of the vocalizations of deaf children has been obtained that it will be possible to program the SAID system to improve the vocalizations of these children. At present this project is still in the early planning stages.

Personality Variables in the Acquisition of Pronunciation of a Second Language (A. Z. Guiora, H. L. Lane, & L. A. Bosworth)

A set of personality variables will be correlated with ability to approximate a native accent in the acquisition of French. It is hypothesized that empathy is a necessary condition for the acquisition of authenticity of pronunciation. Greater authenticity of pronunciation is expected to correlate with greater empathic ability.

A group of approximately 40 high school teachers of French will be pretested on language proficiency, intelligence, and gross personality structure. On the basis of this pretesting, a subset of approximately 20 Ss will be identified with comparable proficiency and other scores. These Ss will receive a test of authenticity of French pronunciation designed for this study. A group of high-authenticity Ss and a group of low-authenticity Ss will then be selected, with perhaps eight Ss each. These experimental Ss will then receive an extensive battery of tests aimed at discovering personality variables that discriminate between high- and low-authenticity speakers.

In particular, the battery will include a test, developed for this study, that may have validity as a measure of empathic ability. Haggard and Isaacs (1966), in a recent paper on Micromomentary Expressions (MME) reported that when strips of films of psychotherapeutic sessions are shown at reduced speed (from 24 frames per second to 4 frames per second) facial expressions denoting affective states become discernible. We assume that the ability to perceive subliminal cues is an expression of empathic capacity, and individual differences in the perceptual threshold level (expressed in the lowest number of frames per second needed to discern the cues), coupled with correctness of interpretation of the affective tone of the perceived cues will be an expression of corresponding differences in empathic capacity. We propose to use a strip of film that shows the highest inter-judge reliability (in terms of interpretation of the MME's) in the Haggard and Isaacs study, to show it to Ss in a descending order of speed and to ask them to identify MME's and to interpret their affective tones. Individual differences will be expressed in the frame-per-second score and the correctness or incorrectness of the interpretation, as determined by the judges in the Haggard-Isaacs study.

The Acquisition of Japanese as a Native Language (David McNeill, Nobuko B. McNeill, & Yasuko Maeda)

Our collection of the speech of two Japanese children, both of whom are now two-and-one-half years old, continues apace, and several grammatical analyses have been carried out. One finding is that Japanese children, like American and Russian children, incorporate the basic grammatical relations (subject-predicate, verb-object, modifier-head) in their earliest patterned speech, even though these relations are not consistently defined in the speech they receive from their parents. A second finding is that the development of grammar and the use of names are quite distinct in children: they take place simultaneously, but naming does not support grammar. A third finding concerns the use of negation in sentences. The first negatives of Japanese children are identical with the first negatives of American and Russian children, and none resemble the negatives of adult grammar. These findings support the hypothesis that linguistic theory describes an innate capacity for language.

Can the Mind Look for Two Things at Once? (David McNeill & Carl Cohen)

Sternberg has developed a strikingly simple technique for studying the way in which people search their memories for the presence of certain information. He defines a "positive set" for his Ss, most often a set of digits, which they then search to determine whether or not subsequently presented digits are members. A consistent finding is that Ss' reaction time in this experiment depends only on the size of the positive set. It is not different when the digit sought is or is not in the set. Nor is it different when the digit sought is early or late in the number series. Sternberg concludes that Ss exhaustively search the positive set, from start to finish, even when registering a match early in the search for a low number that belongs to the positive set. An alternative interpretation is that Ss stop searching whenever they register a match, but that the positive set is stored on an endless loop that Ss enter at random points. With either interpretation, however, one can ask the following question: when the positive set is organized into two categories, say letters and digits, can Ss reduce the time for search by exploiting the hierarchical organization of the positive set? We are now commencing research directed toward this question.

Suppose the positive set contains four items, two digits and two letters. If an S can exploit this hierarchical organization of the positive set, then his search can be limited to a list of two items, regardless of the kind of item sought. The time for search, therefore, should be the time to search a two-item list, not a four-item list. There are two ways in which such a reduction could come about, and our experiment is designed to distinguish between them. On the one hand, a S could search the two constituents of the positive set simultaneously. Alternatively, he could eliminate the irrelevant category before beginning to search the relevant category. We can distinguish between these possibilities by defining positive sets with membership unequally divided between the two constituents. If Ss search constituents simultaneously, the time necessary for search will depend on the size of the larger constituent, regardless of the kind of item sought. If, on the other hand, Ss eliminate the irrelevant constituent before beginning their search, the time for search will depend on the size of the relevant constituent and therefore on the kind of item sought.

A Comparison of the Ability of Normal and Retarded Children to Understand Transformed Sentences (M. Semmel, L. Barritt, & S. Bennett)

It is the purpose of this study to compare the ability of MA and CA matched normal and retarded children to interpret "kernel" and transformed sentences. It is hypothesized that normal children will find this task easier than their retarded counterparts. It is anticipated that the data for this study will be collected during the summer and that data analysis will begin in the fall.

Group C

An Analysis of the Syntactical Differences Between English and French Which Cause the Most Difficulty to Speakers of English Learning French (Donald Dugas & Shirley Willard)

Errors are being culled from a corpus of some 500 French compositions done as homework by students of French 361-362, at the University of Michigan. The most frequent errors will be defined as persistent because: a) they have been committed by students who have chosen to go beyond the elementary level; b) the students made these errors while working under ideal conditions: students were under no great constraints of time and could make use of references to check their grammar.

Error frequencies will be used to determine a hierarchy of difficulty. This will then be compared to a linguistic hierarchy of difficulty proposed by Stockwell (Robert P. Stockwell, J. Donald Bowen, & John W. Martin, The Grammatical Structures of English and Spanish, University of Chicago Press, 1964) to see whether our findings permit us to confirm, refine, or reject that proposal.

Selected areas of difficulty will then become the focus of contrastive analysis.

Further Studies on Answer-Observing in Programmed Instruction (G. L. Geis & S. Fisher)

The series of studies recently conducted by Geis et al. indicates that further research should be carrried out on (1) the controls over answer-observing in programs, (2) the effects of the feedback one receives on his performance during instruction and (3) possible reinforcers in self instruction.

We plan to conduct a series of studies to examine changes in a variety of dependent variables (answer-observing, frame errors, and pretest and posttest scores) as a function of payment for answer-observing and for posttest performance.

We plan to use a modified Foringer teaching machine to present the first few hundred frames of two different programs, to five groups of about 10 Ss each. All groups will be pretested and posttested with parallel achievement tests.

Group 1. Ss taking the program will be paid 1¢ for observing each answer in the program ("Answer-observing" is defined as moving the answer slide aside to reveal the answer.) Ss will also be paid 5¢ per correct posttest item.

Group 2. Ss will be informed that they will lose, from their total subject fee, 1¢ for each answer they observe; that they will be paid 5¢ per correct item on the post-test; and that they will receive a subject fee.

Group 3. Ss will be paid only for correct items on the posttest. Answer-observing will be recorded as in the other groups but monetary reward will not be contingent upon observing.

Group 4. Ss will be paid a set fee without regard either to answer-observing or posttest score.

Group 5. Ss will be paid 1¢ for looking at an answer in the program plus a set fee.

The description above corresponds to the instructions to the Ss in regard to contingencies of payment. All Ss' payments, however, will be equalized at the end of the experiment by a fee that will be adjusted on the basis of previously earned money.

Differential Reinforcement of a Vocal Operant (Stephen F. Knapp)

While previous studies have demonstrated that the vocal response /u/ can be changed in duration by differential reinforcement, this study plans also to place two other parameters, pitch and amplitude, under reinforcement control. Thus, the first goal of the study is to determine the malleability of these three parameters in isolation.

The second goal is to investigate the feasibility of controlling (through reinforcement) two or more of these parameters simultaneously. Consequently, the optimal sequence can be determined for advancing an S from a given response range of pitch, amplitude, and duration to a new response range.

A computer program has been prepared for measuring precisely the peak amplitude, the peak pitch, and the duration of each response. From the first 26 responses a criterion response is established eight standard deviations above the mean. An upper limit (18 standard deviations), a lower limit (minus two standard deviations), and a step size (1/10 of one standard deviation) are also established. So long as the percentage of reinforced responses is above 80, the upper limit is decreased one (or more) step(s) and the lower limit is increased one (or more) step(s) after each reinforced response. The E can make reinforcement contingent upon any combination of parameters (singly, doubly, or triply). The combination can be changed once the criterion has been reached (+ or - 1/2 standard deviation) for ten consecutive responses; the parameter criteria used previously remain in effect, and the new ones are added. Responses are reinforced by advancing an add-subtract counter. Nonreinforced responses result in the subtraction of one point from the total of the counter. Responding is controlled by a red light that signals that the computer is ready for the next response. Initially, male and female college students will serve as Ss.

The computer records the data on punched paper tape and plots them on a graphic recorder.

Studies of Behavior Change in a Modified Free-Operant Classroom Environment (D. E. P. Smith)

Classes of 4-8 Ss with reading disabilities, ages 8-17, meet for 40 minutes, four days per week. All visual and auditory instructional materials are programmed.

Teachers have been trained to "not respond" to any behavior except rule-testing. Two carefully defined rules are enforced by restatement after every violation. Ss' behavior is recorded in three-second intervals by concealed observers. Behaviors are defined by a taxonomy of classroom behaviors determined to be relevant to behavior change. Data are mapped on a Flander's Matrix for analysis of patterns of change.

Contingency Management of Verbal Behavior (Dale M. Brethower)

Two trainable retardates, each with a functional vocabulary of no more than 2-3 words, were seen individually in 20-30 minute sessions twice a week during February through May, 1966. Procedures were used which, requiring no special equipment, could be used by classroom teachers. The major dependent variable was the frequency of voiced vocalizations by the two Ss. A variety of experimental procedures were used to influence vocalization and other behaviors relevant to language acquisition.

The Effects on Second-Language Fluency of Motivated Communication in the Language During Sensitivity Training (H. Lane, A. Guiora, R. Hertel, & C. Sisson)

When we speak to another person in our native language, it is usually the case that the motives for speaking and the things we say are intimately related. If we report an observation, it is usually because we have something to report; if we make a request it is because there is something we want. When these functional controls do not operate on what we say, as in reading an observation or reading a request, the language is being put to a quite different use, and this is apparent from several features of the speaker's performance. To keep distinct the two kinds of controls over speaking, we may call the speech produced by the former functional and that produced by the latter intraverbal.

When we examine second-language instruction in this light, we are led to an interesting conclusion. The student's use of his native language is primarily functional. The use of the foreign language by its native speakers is primarily functional. The avowed goal of the audio-lingual course is to provide functional use of the foreign language, and the text materials generally sample functional episodes in that language. Nevertheless, the course of instruction is almost purely intraverbal; the student rarely speaks under functional control. In the early stages of learning the second language (that is, during the first two years which constitute the entire contact with the language for most students), the student rarely asks, in the second language, for something that he wants, rarely reports something that he has in fact observed. "Regardez ces chevaux," says the student, in the absence of horses, a listener, and a reason for getting the one to look at the other. In the next moment he may say, in his native language, "look at that homework assignment" in the presence of an audience, an assignment and a motive. No wonder his language performance differs in the two cases! In the present study we considered that the absence of functional controls over speech during second-language instruction might be partly responsible for the limited fluency attained by most students.

To examine this notion, we employed a "sensitivity group" as the setting for an experiment. In this setting, virtually all communication is under functional control, and the group leader can, to a degree, regulate the intensity of motivation of the speakers. Rather in the manner of group therapy, the conversation tends to focus on issues important to the speakers, and each is able and often desires greatly to report, request, adjure, and the like. We hypothesized that if a sensitivity group, comprised of fledgling speakers of a second language, were conducted exclusively in that language the fluency of the participants would be enhanced. To ensure that any improvement in fluency could be attributed to the opportunity for functional rather than intraverbal use of the language, we arranged a control group of students who engaged in second-language conversations under the supervision of a teaching fellow. The 16 students who comprised the experimental and control groups were selected from a larger population, on the basis of several measures of performance and aptitude, so that the groups sampled a range of fluency and were very closely matched.

The groups met for two hours each week, for eight weeks, while also attending classes in an intensified, introductory French course two hours each day. At the end of the term, the students received a battery of psychological tests, designed to assess several facets of fluency in the second language, including: speed of encoding and decoding, rate of speech, patterning of semantic associations, extent of "habituated direct association," and other measures. The findings are now undergoing statistical analysis.

Group D

Psychological Reality of the Paragraph as a Grammatical Structure (Frank Koen, Alton Becker, Richard Young, & Steven Fisher)

This is the first in a series of experiments with the goal of determining whether there are functional syntactic structures beyond the level of the individual sentence and, if so, of establishing the nature of these structures. The purposes of the present experiment were (a) to develop a set of standard experimental passages of prose, (b) to determine the probability with which paragraph markers are assigned to each inter-sentence interval, (c) to compare the distributions of paragraph markers in normal English passages and in nonsense passages derived from them, (d) to compare both these distributions with that derived from the Becker-Young theory of rhetoric, and (e) to discover the cues to which Ss respond in making paragraphing decisions. The experimental stimuli were four expository paragraphs, each of a different grammatical structure. From these were derived a total of 12 experimental passages, half in normal English and half nonsense (i.e., all content words replaced by paralogs, but with function words and grammatical endings retained), from which all paragraph indentations were removed. Forty-eight college undergraduates indicated where they thought paragraph boundaries should be. All the data have been collected, and tabulation and analysis have begun.

III. Dissemination Activities

Center for Research on Language and Language Behavior

A. Articles, Contributions to Edited Volumes, Books

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Young, R. E., & Becker, A. L. Toward a modern theory of rhetoric: a tagmemic contribution. In Language and learning. New York: Harcourt, Brace, & World, Inc., 1966.

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Addresses

Barritt, L. S. "A syntactic analysis of retardate free-associate responding," "A critical evaluation of the Illinois Test of Psycholinguistic Abilities," "A comparison of the psycholinguistic functioning of 'educationally-deprived' and 'educationally-advantaged' children." American Educational Research Association, Chicago, February 17-19, 1966.

Barritt, L. S. Speaker, Sixth Annual Michigan School Testing Conference, University of Michigan, March 16, 1966.

Barritt, L. S. "A syntactic analysis of retardate free-associate responding." American Association on Mental Deficiency, Chicago, May 10, 1966.

Brethower, D. M. Lectures on behavioral aspects of communication. Westinghouse of Canada, Ltd., Hamilton, Ontario, April 15-17, 1966.

Brethower, D. M. Lectures, Allied Stores, New York, New York, April 25-26, 1966.

Brethower, D. M. Lectures, Union Bank, Los Angeles, Calif., June 1-3, 1966.

Catford, J. C. "Review of research needs in TENES." TENES Conference, Chicago, February 1966 (TENES = Teaching of English in Non-English Speakers).

Catford, J. C. "Airflow in speech and the teaching of pronunciation." Conference on the Teaching of English to Speakers of Other Languages, New York City, March 1966.

Catford, J. C. "Patterns of multilingualism." Center for Applied Linguistics Conference on Second-Language Teaching, Quebec, April 1966.

Catford, J. C. "Sociolinguistics and translation in language teaching." ATESL Meeting, NAISA Conf., Chicago, May 1966.

Catford, J. C. "The analysis of writing: graphetics and graphology," Center for Research on Language and Language Behavior Seminar, Ann Arbor, Michigan, May 27, 1966.

Catford, J. C. "J. R. Firth" and "Linguistics in Britain," Voice of America Symposium on Linguistics, in preparation.

Companys, E. M. Lecture, St. Paul Seminary, Saginaw, Mich., August 29-30, 1966.

Geis, G. L. "Education--the modification of behavior," Annual Conference of Academic Deans, Philadelphia, Pa., January 11, 1966.

Geis, G. L. "Answer-observing in programed instruction," National Society for Programmed Instruction Annual Meeting, St. Louis, Missouri, April 1966.

Geis, G. L. "Rats, children and machines." Address, University of the South, Sewanee, Tenn., May 1966.

Lane, H. L. "Psychological considerations prompted by _A linguistic theory of translation_ (text by J. C. Catford), Linguistics Club, Univ. of Michigan, Ann Arbor, Michigan, January 13, 1966.

Lane, H. L. Address, Northeast Conference of Language Teachers, New York City, April 1, 1966.

Lane, H. L. Address, Teachers Conf., Tuskegee, Alabama, June 7, 1966.

McNeill, D. "Acquisition of language," Verbal Behavior Conf., University of Kentucky, Lexington, Kentucky, March 12-15, 1966.

McNeill, D. "Developmental Psycholinguistics," Conf. on Psycholinguistics, Edinburgh, Scotland, March 28-April 1, 1966.

McNeill, D. Lectures, Yeshiva Univ., June 6-7, 1966.

McNeill, D. Lectures, University of Connecticut, June 24, 1966.

McNeill, D. Lectures, Berkshire Country Day School, July 1966.

McNeill, D. Lectures, Central Institute for the Deaf, St. Louis, Mo., July 1966.

Pike, K. L. Intermittent lectures, University of Ghana, Accra, Ghana, November 3-January 7, 1966.

Pike, K. L. Intermittent lectures, University of Nigeria, Nsukka, Nigeria, January 20-March 15, 1966.

Pike, K. L. Lectures and monolingual demonstration, University of Ibadan, Nigeria, January 12, 1966.

Pike, K. L. Lectures, University of Azria, Zaria, Nigeria, January 17, 1966.

Pike, K. L. "Comments on African languages; Part I: Phonological hierarchy and tone; Part II: Some rank-structured components of discourse," Sixth Annual West African Language Congress in Yaounde, Camerouns, March 17, 1966.

Pike, K. L. Commencement address, Seattle Pacific College, Seattle, Washington., June 12, 1966.

Semmel, M. I. "Language of the deprived," Ann Arbor Public School Staff Study Day Conf., Ann Arbor, Michigan, January 28, 1966.

Semmel, M. I. Research colloquium, Language research with retarded children, Indiana University, Bloomington, Indiana, February 14, 1966.

Semmel, M. I. "A syntactic analysis of retardate free-associate responding" (paper prepared with others), American Educational Research Association, Chicago, February 18, 1966.

Semmel, M. I. "A critical evaluation of the Illinois. Test of Psycholinguistic Abilities" (paper prepared with others), American Educational Research Association, Chicago, February 19, 1966.

Semmel, M. I. "Language training for the trainable retarded child," Regional Program for Trainable Retarded, Hamtramck, Michigan, February 28, 1966.

Semmel, M. I. "Learning disabilities in children," Livonia Public School Staff, Livonia, Michigan, March 8, 1966.

Semmel, M. I. "The teacher's role in research," State Council on Exceptional Children Convention, Grand Rapids, Michigan, April 2, 1966.

Semmel, M. I. "Recruitment of special education staff," Council on Exceptional Children Convention, Toronto, Canada, April 18, 1966.

Semmel, M. I. "Grammatical form-class in word associations of retarded and normal children," National Convention of American Association on Mental Deficiency, Chicago, Illinois, May 12, 1966.

Semmel, M. I. "Language problems and their assessment for mentally-retarded children," Research Roundup, University of California at Los Angeles, June 28, 1966.

Smith, D. E. P. "Training in composition by programmed materials," Lansing Community College, Lansing, Michigan, January 6, 1966.

Smith, D. E. P. "Michigan language program for training perceptual skills," Michigan Association of Children with Learning Disabilities, Clawson, Michigan, January 17, 1966.

Smith, D. E. P. Training seminar: "Innovations in teaching," Friends School of Detroit, Detroit, Michigan, January 20, 1966.

Smith, D. E. P. "Preparing instructional material," Institute on Desegregated Schools, University of Detroit, Detroit, Michigan, February 26, 1966.

Smith, D. E. P. "Training perceptual skills," Michigan Reading Association, East Lansing, Michigan, March 3, 1966.

Tarte, R. D., & Gadlin, H. "Effects of experimenter differences on galvanic skin resistance," Midwest Psychological Association, Chicago, May 1966.

Tikofsky, R. S. "Emotional and intellectual considerations in the rehabilitation of stroke patients," Conference of Texas Institute for Rehabilitation and Research, Houston, Texas, January 20, 1966.

Weener, P. "Implications of new developments in linguistics and psycholinguistics for the teaching of the language arts," State Committee on Curriculum in the Language Arts, Ann Arbor, Michigan, January 28, 1966.

Weener, P., Barritt, L. S., & Semmel, M. I. "A critical evaluation of the Illinois Test of Psycholinguistic Abilities," American Educational Research Association, Chicago, Illinois, February 17-19, 1966.

Weener, P. "The syntactical structures of preschool children from contrasting social environments," International Convention of the Council for Exceptional Children, Toronto, Canada, April 17-24, 1966.

Young, R. E. "Rhetoric and linguistics" (series of six lectures), NDEA Summer Conference, Iowa State Teachers College, Cedar Falls, Iowa, July 11-13, 1966.

Young, R. E. "Rhetoric and linguistics," NDEA Summer Conference, Ball State Teachers College, Muncie, Indiana, July 26, 1966.

Young, R. E. "Argumentative structures in technical writing," University of Michigan Engineering Summer Conference, Ann Arbor, Michigan, August 4, 1966.

Workshops, Panels, Colloquia, Symposia, Seminars, Conventions

Barritt, L. S. CRLLB Research Colloquium, Ann Arbor, Michigan, January 18, 1966.

Barritt, L. S. Consultant on Language Development, Ann Arbor Schools Staff Study Day, Ann Arbor, Michigan, January 28, 1966.

Barritt, L. S. American Educational Research Association/NCME, Chicago, Ill. February 17-19, 1966.

Barritt, L. S. Michigan School Testing Conference, Ann Arbor, Michigan, March 16, 1966.

Barritt, L. S. Michigan Conference on Education, Lansing, Michigan, May 14, 1966.

Becker, A. L. Association for Asian Studies, New York, April 4-6, 1966.

Brend, Ruth. Associate Director of Summer Institute of Linguistics at Norman, Oklahoma, Summer 1966.

Brethower, D. M. Human Relations Seminar, General Motors Institute, Hillsdale, Michigan, June 24, 1966.

Catford, J. C. Chairman, Committee on Research in Teaching English to Non-English Speakers, Chicago, Ill., February 11-12, 1966.

Catford, J. C. Chairman, Session on Research Needs, CAL Conference on Second Language Teaching and Bilingualism, Quebec, Canada, April 1966.

Catford, J. C. Panel member, ATESL Workshop "Improving Methods in TESL," NAFSA Conference, Chicago, Illinois, May 1966.

Companys, E. M. Linguistique appliquée à l'enseignement des langues, Language Teaching Improvement Workshop organized by the Association des Professeurs de Langues Vivantes de l'Académie de Poitiers, and the Centre Régional de Documentation Pédagogique de l'Académie de Poitiers, March 1966.

Companys, E. M. Magnétophones et laboratoires de langues, Audiovisual Language Teaching Workshop, organized by the Ministère de l'Education Nationale, Paris, France, April 1966.

Companys, E. M. Les tests de niveau en langues, French Improvement Workshop, Flint, Michigan, May 1966.

Dugas, D. Northeast Conference on the Teaching of Languages, New York City, March 31-April 2, 1966.

Geis, G. L. Workshop in Programmed Instruction, Center for Programmed Learning for Business, University of Michigan, Ann Arbor, Michigan, monthly throughout the year, 1966.

Geis, G. L. English workshop, Tuskegee Institute, Tuskegee, Alabama, June 1966.

Lane, H. L. Chairman, Language Seminar, University of Michigan, February 11, 1966.

Lane, H. L. Conference on thesaurus development. National Institute of Health, Bethesda, Maryland, May 1966.

Lane, H. L. Conference on foreign language pedagogy. Harcourt, Brace, & World, New York City, June 1966.

McNeill, D. Colloquium, Center for Cognitive Studies, Harvard University, Cambridge, Massachusetts, January 20, 1966.

McNeill, D. Colloquium, University of Illinois, February 1966.

McNeill, D. Faculty seminar on "Psycholinguistics and Language Acquisition," Earlham College, Richmond, Indiana, April 6-7, 1966.

Pike, K. L. Linguistic workshop, University of Ghana, Accra, Ghana, Nov. 1-Jan. 7, 1966.

Pike, K. L. Linguistic workshop, University of Nigeria, Nsukka, Nigeria, January 20-March 15, 1966.

Semmel, M. I. Colloquium: "Language research with retarded subjects," Indiana University, Bloomington, Indiana, February 1966.

Semmel, M. I. Conference on Academic Opportunity, Ann Arbor, Michigan, February 13, 1966.

Semmel, M. I. Annual Conference on Academic Opportunity, Ann Arbor, Michigan, February 17-20, 1966.

Semmel, M. I. Annual Convention of State Council on Exceptional Children, Grand Rapids, Michigan, April 2-3, 1966.

Semmel, M. I. Chairman, Panel: Curricular Considerations in Programs for the TMR: Application of Theoretical Models. National Council for Exceptional Children Convention, Toronto, Canada, April 22, 1966.

Semmel, M. I. Annual Convention of American Association on Mental Deficiency, Chicago, Illinois, May 13, 1966.

Smith, D. E. P. Office of Economic Opportunity Workshop, Oakland County, January 21, 1966.

Smith, D. E. P. Programming Workshop, Sienna Heights College, March 12, 1966.

Smith, D. E. P. NSEA, Title I Workshops (Mich.): Yale Public Schools, April 4, 1966; Waverly Public Schools, April 11, 1966; County Institute, Western Michigan University, Kalamazoo, Michigan, April 27, 1966.

Tikofsky, R. S. VRA Conference, Research Needs in Rehabilitation of Patients with Stroke, Vocational Rehabilitation Association and Texas Institute for Rehabilitation and Research, Baylor Medical School, Houston, Texas, January 19-20, 1966.

Tikofsky, R. S. Short course on aphasia, University of Indiana, Bloomington, Indiana, June 1966.

Tikofsky, R. S., & Tikofsky, Rita. Acoustical Society of America, Boston, June 1-4, 1966.

Weener, P. Council for Exceptional Children. Toronto, Ontario, Canada, April 17-24, 1966.

Weener, P. American Educational Research Association Convention, Chicago, Illinois, February 17-19, 1966.

Young, R. E. Symposium on Educational Research, University of Michigan Extension Service, Ann Arbor, Michigan, March 24, 1966.

Young, R. E. Workshop on Rhetoric and Linguistics, NDEA Summer Conference, Iowa State Teachers College, Cedar Falls, Iowa, July 11-13, 1966.

Young, R. E. Symposium on Rhetoric and Linguistics, NDEA Summer Conference, Ball State Teachers College, Muncie, Indiana, July 27, 1966.

Young, R. E. Technical Writing Workshops, University of Michigan Engineering Summer Conference, Ann Arbor, Michigan, August 1-5, 1966.

Zale, E. M. Conference, Vital Issues in Language Sciences, Washington, D. C., Warrenton, Virginia, March 2-4, 1966.

Zale, E. M. Workshop: The Past and the Future of the Communications Course on the University Level, Conference on College Composition and Communication, Denver, Colorado, March 23-26, 1966.

IV. PERSONNEL

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ALLEN, George. Graduate student, Department of Communication Sciences. Research assistant in Group A.

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BRETHOWER, Dale M. Graduate student, School of Education. Research assistant in Group C.

BUTZBAUGH, Judith. Graduate student, School of Education. Research assistant in Group C.

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CARLSON, David. Graduate student, Department of Industrial Engineering. Research assistant in Group E.

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COMPANYS, Emmanuel. Dip. l'Institut Normal d'Etudes Françaises, University de Toulouse, France. Member, CRLLB, in Group A.

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FISHER, Steven. Undergraduate. Research assistant in Group A.

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KNAPP, Stephen F. B.A. Hamilton. Research assistant in Group C.

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KOEN, Michael. Messenger.

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PAPER, Herbert H. Ph.D. Chicago. Chairman, Department of Linguistics. Member of Center's Executive Committee.

PARIS[illegible], Jacqueline. Secretary.

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PETERSON, Lydia G. Dissemination secretary.

PHILIP, Franklin J. Graduate student, Department of Philosophy. Research assistant in Group E.

PIKE, Kenneth L. Ph.D. Michigan. Professor of Linguistics. Chairman, Group D.

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RAMMUNY, Raji. Ph.D. Michigan. Lecturer, Department of Near Eastern Languages and Literatures. Member, CRLLB, in Group A.

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ROSS, Strange. Mag. Art. University of Copenhagen. Member, CRLLB, in group A.

ROTHKRUG, Françoise. B.A. University of Paris. Research assistant in Group E.

RUSSMAN, Mary. Secretary.

SEMMEL, Melvyn I. Ed.D. George Peabody Institute. Associate Professor, School of Education. Member, CRLLB, in Group B.

SEMMELROTH, Carl C. Graduate student, Department of Psychology. Research assistant in Group C.

SHEPPARD, William C. Graduate student, Department of Psychology. Research assistant in Group A.

SISSON, Cyrus R. Graduate student, Psycholinguistics. Research assistant in Group C.

SMITH, Donald E. P. Ph.D. Cornell. Professor of Education. Member, CRLLB, in Group C.

SMITH, George. Graduate student, School of Education. Research assistant in Group E.

SUTCLIFFE, Rita. Undergraduate. Research assistant in Group B.

SPENSER, Dwight. Undergraduate. Research assistant in Group A.

TAR[illegible] Robert D. Ph.D. Michigan. Associate Director of the Center (Administration).

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WASSERSTROM, Jan. Secretary.

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WEINSTOCK, Andrew. Graduate student, Department of Psychology. Research assistant in Group A.

WILLARD, Shirley. M.A. Michigan. Research assistant in Group C.

YOUNG, Richard E. Ph.D. Michigan. Assistant Professor of English, College of Engineering. Member, CRLLB, in Group D.

ZALE, Eric M. Ph.D. Michigan. Associate Director of the Center (Dissemination).